The CRUSHED STONE JOURNAL

In This Issue

The Roots of American Liberty

And Now, What of Research?

Developments in Asphalt Pavement Construction

Adhesion of Bitumen to Aggregates

Defense Against Claims for Damage from Blasting

Recent and Proposed Federal Legislation Relating to Industry

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BULLETIN No. 3

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BULLETIN No. 6

The Bituminous Macadam Pavement

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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Contents

Page

The Roots of American Liberty
—H. W. Prentis, Jr. - - - - - - - 3

And Now, What of Research?
—A. T. Goldbeck - - - - - - - - 10

Developments in Asphalt Pavement Construction
—Bernard E. Gray - - - - - - - - 15

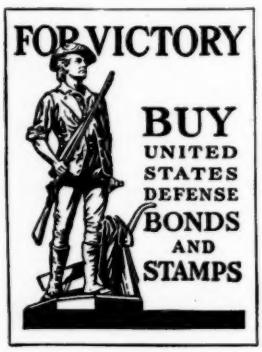
Adhesion of Bitumen to Aggregates
—Albert V. Bratt - - - - - - - - 22

Defense Against Claims for Damage from Blasting
—Harold Williams - - - - - - - - 28

Recent and Proposed Federal Legislation Relating to Industry
—John C. Gall - - - - - - - - - 32

As A Nation-

Unless we are prepared for the worst, we aren't prepared at all, so let us begrudge no effort, no precaution . . . ORDINARY PRUDENCE commands us to purchase United States Victory Bonds to the limit of our ability . . . NOW —and throughout the duration.



THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

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The Roots of American Liberty

By H. W. PRENTIS, JR.

President, Armstrong Cork Company, Lancaster, Pa., Past President, National Association of Manufacturers

• As the principal speaker on the occasion of our Silver Anniversary Banquet, Mr. Prentis gave us a most profound and eloquent address. His penetrating analysis of this fundamentally important subject should be of universal interest.

LIKE most of you probably, I am a product of the American public school system from kindergarten through college, and my father used to tell me that everyone who was educated at public expense owed a peculiar debt to his country. I have no illusions about ever being able to pay off that indebtedness. However, the tragic events in Europe in the last twenty years and the grave crisis that we now face in America move me with the deep and earnest desire to make whatever contribution I can to a better understanding on the part of all of us of the foundations of our freedom. So I come to you tonight to pass along some of the things I was not taught while I was in school; some of the things that I believe every American citizen must learn and come to believe in very quickly and very sincerely if we are to preserve the blessings of American liberty to oncoming generations.

Our country has spoken in unmistakable terms in these recent fateful weeks. The die is cast. We go forth again to make the world safe for its self-governing peoples. Regardless of consequences, we have decided as a nation to offer "our lives, our fortunes and our sacred honor" on the altars of the liberty of mankind. Our first duty is to give full support to our government and its military forces at this hour of crisis. Granted that, our ability to win through to a decisive victory cannot be questioned. But in that connection, it is imperative that we rekindle the ancient altar fires of freedom in the hearts of all our people since men fight valiantly only for ideals which they understand and in which they believe. Physical armaments are never adequate in themselves alone. Intellectual and spiritual ramparts are equally essential. Therefore, to be fully armed to meet the present crisis, America must understand and have faith in the foundations of her freedom. You will hear from me tonight, therefore, not about airplanes, tanks and battleships and the multifarious problems of mass production involved in modern war, but instead, regarding the eternal principles on which our freedom rests.

In this connection a terrible indictment can be justly drawn against American business and professional men and women, including teachers and preachers. We have been so smug and complacent. We have assumed so carelessly that our liberties were sacrosanct. We have so flagrantly neglected the duties of citizenship in a republic. We have so completely forgotten that the maintenance of representative democracy requires an exceptionally high degree of intelligent understanding and active cooperation on the part of all its citizens. We have been so busy with our personal

[1] Presented at the Twenty-Fifth Annual Convention of the National Crushed Stone Association at Cincinnati, Ohio, February 3, 1942.

affairs—so absorbed in material things—that we have tried to live without a political philosophy, and that cannot be done successfully in this country or anywhere else in the world. If the average American business man knew as little about his product as he does about his governmental and economic system, he would soon find himself in the throes of bankruptcy.

We all recognize, of course, that to wage modern war successfully requires the temporary relinquishment of many of our cherished freedoms. The devil must be fought with fire. Hence it is doubly important that at a time like this every citizen should be on guard and alert lest, when the present emergency is over, we find ourselves with only the empty shell of the Republic we are now giving our lives and treasure to defend. History shows that liberty has been lost far more frequently by the complacency, indifference and ignorance of the citizenry themselves than by executive fiat or military conquest. Daniel Webster said: "God grants liberty only to those who love it and will always guard and defend it."

Unfortunately freedom and physical luxury seem to be congenitally incompatible. They have never remained long in political wedlock, but are soon divorced in the court of dictatorship. The love of liberty, we must ever remember, was not born in an automobile, lullabied with radio, nourished with quick-frozen foods, raised in central-heated houses, clothed in synthetic fabrics, entertained by movies or educated in palatial structures of granite and marble! It was born in a dungeon—in the fetters of tyranny. The time-worn historical cycle has been: From fetters to faith; from faith to freedom; from freedom to folly; from folly to fear; then from fear back to fetters once more. We in 20th century America are now about midway in the process. Let it not be written of us that having eyes, we saw not, and having ears, we heard not, the plainly written warnings of the past!

Montesquieu said: "A government is like everything else. To preserve it, we must love it." How, I ask you, can any human institution be created in the first place and then continue to prosper if no one takes the trouble to acquire faith in it and then is willing to fight for its principles? How can any business institution, any club, any church, let alone popular self-government, hope to remain in existence unless its adherents are active and articulate in its support? Yet how many able business men of your acquaintance could in public debate tonight with Earl Browder, Norman Thomas or some well-meaning new liberal, make even a sketchy defense of the faith of our fathers? The truth of the matter is that the average American has never taken the time to study and understand the principles on which our Republic was founded. Meanwhile, the collectivists have been crying their theories from every housetop. As a result a host of our people have become easy prey for the social theorist who takes them up on a high mountain and shows them the kingdoms of easy living and the will-o'-the-wisp economic abundance that they allegedly can have if they will only follow his fatuous leadership. Now, as always, an intelligent, believing and vocal citizenry is the Vitamin A of representative democracy.

The roots of American liberty are sunk deep in philosophic and religious soil. They go down to those far-off days in ancient Greece when men sought to discover the requirements for living a good life in a republic of free men, and to those brief years of Christ's ministry in Judea, proclaiming the brotherhood of man and the fatherhood of God. At the very base of the taproot we find Socrates and Aristotle. Then the life-giving sap of their basic thinking vitalizes successively the minds of Cicero and Lucian, St. Augustine, William of Ockham, John Wyclif, Erasmus, Calvin, Montaigne, Hobbes, Milton, Locke, Adam Smith, most of the founders of our government here in the United States and, more recently, Emerson and William James. These philosophers have always held in broad terms that there is a vital relation between freedom and reason; that an act is voluntary if the person concerned is not coerced by anybody and is old enough to understand the meaning of what he is doing. Freedom, in other words, is intelligent behavior. Thus emphasis is placed on understanding and on the development of reason and intelligence. And society has been organized on the basis of a meeting of minds and of mutual respect.

Three great historic currents of thought combined to foster and develop this concept among the English-speaking peoples: First, the Nominalist philosophy of the 14th century; second, the British Reformation two hundred years before Luther; and third, the revival of classical learning in England in the 16th century.

Neither the time nor the occasion permits an extended discussion of these three momentous movements. Suffice it to say that the English monk, William of Ockham, the founder of the Nominalistic school of philosophy, postulated the fundamental

tenet of English and American liberalism—individualism—about the year 1325 when he taught at Oxford. Applying that concept to government, the English speaking peoples have said ever since that the reality of the individual and his concrete experience in a real world must be respected. Here is where British thought stands out in stark contrast to the romanticism of German philosophy.

John Wyclif, a cleric, placed translations of the New Testament in the hands of the common people all over England; set up "conventicles" or congresses where the populace got together for prayer and worship; and taught that the sacraments of the church meant nothing unless the individual who accepts them knows what he is doing and what they signify. As a result, our forefathers came to the shores of the American continent impregnated with the principles of personal moral responsibility, the right of private judgment and the right of free assembly which, together, filled them with a fervent passion and unshakable belief in the inward spirituality of the individual. They based their political philosophy and their economic system on the concept that there is something about the human spirit that is sacred; that there is a place in the human soul that no government and no man may justly enter, where reside those inalienable rights that the Declaration of Independence later thundered so eloquently to the world.

With this religious principle as the foundation, our forefathers erected the tripartite structure—the tripod—on which our individual freedom rests today. First they maintained that if man did possess a sacred personality, he had the right to choose who should rule over him. On that thesis they reared the first supporting tower of our edifice of liberty—representative constitutional democracy. Again they argued that since man possessed a sacred personality, he had the right to think, speak, assemble and worship as he saw fit. On that concept they erected the second tower of the structure of liberty—civil and religious freedom. And finally they reasoned that any man endowed with a sacred personality had the right to possess for himself such portion of the God-given resources of the earth as he could win by honest toil and effort. Thus they asserted every individual's right to private property and economic activity of his own choice, and on that basic tenet they built the third supporting tower of their temple of liberty—free private enterprise. These three towers stand or fall together. Destroy any one of them, and the whole structure of freedom soon collapses. Mr. William Green, President of the American Federation of Labor, emphasized that point recently when he said: "Individual liberty and security are inseparably associated with the vital principle of free enterprise and the private ownership of property."

This whole process was not accomplished haphazardly. It was not the result of chance or circumstance. On the contrary, it was the fruit of generations of thought and sweat and tears and blood. That tripod of freedom is our most precious heritage in America today. And all of it goes back to that spiritual principle of the sacredness of the individual soul which is common to all three of our great religious faiths—Judaism, Catholicism and Protestantism—a principle for which the church, using the word in its broadest sense, has fought through the centuries, and a principle which all collectivists, regardless of whether they call themselves communists, socialists, fascists, nazis, or new liberals, deny.

The third factor which I mentioned some moments ago as being responsible for the development of English liberalism was the revival of classical learning in England in the 16th century. To round out this point, we must now turn back to ancient Greece and Rome. The Greeks appear to have developed a love of liberty very similar to that which has characterized the English-speaking peoples. In the 5th century B. C. they drove the Persians back across the Aegean Sea and for the first time felt free of the threat of foreign domination and able to develop their own peculiar civilization. Almost the first question they asked was: "How can we live a good life?"—meaning by that phrase how they could be most happy and free to attain a full measure of intellectual and spiritual maturity. This question led to another: "What is good?" And since these people could not fall back on tradition or custom or tribal religion for an answer, they were obliged to try to think the question through on their own initiative and make answer on the basis of personal judgment, pioneer thinking and good taste. The fruit of their attack on fundamental questions, such as these, lies at the source of the liberal culture of western Europe and America.

In Plato's famous parable of the cave in the Seventh book of "The Republic," he drove home the point that the mental processes of a free mind and those of the herd are as far apart as the poles. Such thinking consists not merely in what men believe, but how and why. The free man deals with his life in wholly different fashion than does the man whose mind has not been set free. Such a man has, as Aris-

totle points out, mastered his passions; tempered his judgment; will either doubt or believe on the basis of evidence only; will neither seek nor shun danger; and in all his relationships exhibit temperance and poise. Such is the man, according to the ancient Greek philosophers, who has found freedom through the exercise of wisdom. Wherever this concept of the free man has held sway, human life has found dignity and freedom; force has been reduced to a minimum; mutual respect and common counsel have been substituted for coercion; and democratic self-government has developed. Aristotle warns us, however, that democracy tends to evolve into revolution and tyranny. The demagogue eventually appears who excites the passions of the crowd and then lures the people with promises that an abundance of material things will be theirs, if only the existing order be overthrown. How this process Aristotle so accurately describes, is tending to repeat itself in nation after nation in this present day!

Marcus Cicero, who may be regarded as the last great liberal of antiquity, was a great disciple of Aristotle. As consul of the Republic of Rome he crushed the Catiline rebellion. Not long ago I read some of the harangues made to the populace by the leaders of this rebellion, as reported by Sallust. They sounded most familiar. In fact, in their denunciation of capitalists and their demand for the redistribution of wealth, they might have been delivered in Union Square yesterday. Huey Long with his "Every man a king" or Stuart Chase with his "Economy of Abundance" could scarcely have done a better job.

Although Circero was voted the title of "Father of his Country," he was unable to save the republic from the proletarian party, directed by one of the shrewdest politicians that has ever appeared in human history, Julius Caesar. Cicero was liquidated in a purge fomented by Mark Antony and, after that, no man's life or property was safe. Dictatorship succeeded dictatorship, destroying not only the constitution of the republic but eventually all sense of political responsibility among its citizens. Interest in the ordinary duties of citizenship vanished. More and more planned economy followed, which led to more and more economic confusion. The currency was inflated; there was great unemployment in all the principal cities; no less than twenty per cent of the population were on the public payroll; taxes were so high that the farmers were compelled to turn their lands over to the government. Collective farming was attempted but the government could not get people to work because the proletariat no longer had the desire or habit of labor. The people lost political interest. Few cared to hold office. They would not even fight to save themselves. Finally the border was opened and the barbarians were brought in to raise crops and man the defenses.

It was not until fifteen hundred years after Cicero, that a group of Italians in Florence were able to set up a new republic. There, in an academy on the hillside of Fiesole, men began again to think and discuss questions as did the free men of ancient Greece and Rome. Interest in Cicero was renewed; they read and re-read his inspiring words about liberty. From this center came a new group of scholars—men like Erasmus of Rotterdam—who brought this old but ever new source of intellectual inspiration to the peoples of northern Europe and thus laid the foundations for the Revival of Learning in the modern world. Erasmus, who came to Oxford University to teach, Thomas Moore and John Milton carried the philosophy of Socrates and Cicero to Great Britain. Cicero became the great exemplar of patrician virtue in the minds of the free thinking liberals of the 17th and 18th centuries in England and America.

It is a significant fact that practically all the prominent New England patriots were educated in the Boston Latin School in Boston; that the Virginia group, Washington, Randolph, Wythe, Henry, Marshall, Jefferson and Madison, all came directly or indirectly under the influence of Dr. Small of Edinburg University, who taught logic and literature at William and Mary College in Williamsburg for a decade or two preceding the Revolution. In these schools our forefathers became acquainted with Socrates and Aristotle and the great English political philosophers of the 17th and 18th centuries. Nowhere is Ciceronian influence more evident than in The Federalist Papers of Hamilton, Madison and Jay. Jefferson states frankly that the Declaration of Independence contains no new ideas but rests on "the elementary books of public right, as Aristotle, Cicero, Locke, Sidney, etc." Our founding fathers had a political philosophy. They believed in it and knew how to defend it. As an eminent educator has said: "The retention of this philosophy of freedom is the issue on which the survival of our republic will be determined."

According to collectivistic philosophy, the government, which is the sovereign will of man acting as a mass, grants such powers of property and liberty to the people as it sees fit. Contrariwise, according to the philosophy of the English-speaking

peoples, citizens set up a democratic government and grant it only such powers, funds and privileges as the citizens see fit. There is no freedom-saving compromise possible between these two ideas.

In America, the so-called new liberals are convinced that the process of social evolution is inevitably toward a compulsory, planned economy. They welcome the ideal of collectivism but do not want to go the whole distance on the road to Moscow or Berlin. Actually they are reactionaries at heart because, without realizing it, they are advocating policies that will eventually destroy representative democracy, free private enterprise, and civil and religious liberty—the tripod on which human freedom rests.

As a great industrial nation, we have long been accustomed to plan ahead; hence the phrase, national economic planning, has something about it that appeals to almost every one at first blush. However, compulsory national economic planning really rests on a series of delusions. Our national economic planners, in fact, are the modern prototypes of the medicine men of our barbaric ancestors. They actually believe that modern science, if only placed at the behest of all-powerful government, can make the springs of plenty flow for everyone with little work and sacrifice on anybody's part. Economic planners believe that somewhere there actually exist individuals who have the capacity to plan the economic affairs of the whole nation; so as to build a steadily higher standard of living. The stagnation and loss of impetus due to the dilution of personal responsibility and initiative under such a system would be appalling. Furthermore, if the government once starts planning the economic affairs of our basic industries in time of peace, the process will inevitably have to be extended to every phase of our economic life. Our economic processes are so closely interrelated that sooner or later government would have to tell each one of us what we could buy, when and where we could buy it, and at what price; what we could produce, how much we could produce; where we could work and for what wages. There would be no stopping short of the bitter end. Stalin, the Russian dictator, said in 1934: "Without getting rid of capitalism and abandoning the system of private ownership in the means of production, you cannot create planned economy."

The road to compulsory planned economy is the road to state socialism. Once state socialism is a reality, what becomes of the other two legs of the tripod of freedom—representative democracy and civil and religious liberty? Obviously if a group of men calling themselves government were planning ostensibly for the greatest good for the greatest number, they could not brook interference from any individual citizen, no matter how well intentioned that citizen might be. It takes a long time to bring economic programs to fruition. Meanwhile, the economic planners, the government, would have to mold public opinion so as to keep themselves in power. Consequently, government would simply have to control every opinion-forming agency: the radio, the press, the movies, the schools and the church—at least insofar as anything advocated was at variance with the set economic program of the state. In Germany, Russia and Italy you can see that program at work today. And when you start controlling the press, the radio, the movies, the school and the church, what becomes of civil and religious liberty?

In contemplating the rosy predictions made by its eloquent advocates, I have often wondered where we would be today as a nation if a compulsory national planning board had been in existence for the past two or three generations. No doubt you recall the remark of the first President to whom the telephone was shown: "This is truly a remarkable thing but who would ever want to use it?" With the President himself making such an appraisal of a scientific invention, can you imagine any national planning board authorizing the expenditure of the billions of dollars that private enterprise has spent in the past sixty odd years to give us the marvelous system of telephonic communication that we now enjoy throughout the length and breadth of this country?

Napoleon Bonaparte certainly had unusual vision and autocratic power. In fact, he did a great deal of economic planning for France. However when Robert Fulton built a submarine and suggested to the Emperor that he authorize the construction of a fleet of such vessels to destroy the British Navy—the only real obstacle that stood in the way of Napoleon's ambition to conquer Britain—the great Emperor said "No." It was finally private individuals and private enterprise that developed the submarine and placed it at the disposal of government.

The Constitutional Convention held its sessions in Philadelphia in 1787. One afternoon a group of distinguished statesmen, including George Washington, were invited by Fitch to come down to the Delaware River and see the steamboat that he had built. With all the vision that Washington possessed, with all his

interest in the development of the natural resources of this country, he was so skeptical about Fitch's invention that he concluded that the steamboat was not worth investigating and went to a dinner instead. Suppose that the development of steam navigation had depended on the vision and initiative of a national economic planning board, would it be likely that a Queen Mary or a Normandie would ever have crossed the Atlantic in less than four days?

Coming down to modern times, there were 8,000 automobiles in the United States in 1900 which required 80,000 barrels of gasoline annually to operate them. That quantity of gasoline would run the cars now on the roads of this country about an hour and a half. Suppose Mr. Henry Ford had gone to a national economic planning board back in 1900 and said: "I want you to provide gasoline to run 36,000,000 automobiles in 1942." Do you imagine that any governmental body would have followed his suggestion and set about to do what the privately controlled petroleum industry has actually accomplished at the risk of billions of dollars of private capital?

Similar examples could be cited *ad infinitum* but perhaps the crowning illustration of governmental lack of vision is that of Commissioner of Patents Ellsworth, who in 1850 counselled a Congressional committee against the construction of a new building for the Patent Office on the ground that there were not many more inventions in sight! The total number of patents that had been granted in the United States up to that time were 3,327; since then more than two million have been issued!

The fact is that compulsory national economic planning means less planning rather than more planning. Today planning is being done by millions of individuals every day. Our well-being depends directly on the wisdom of these decisions. Fortunately, however, every private decision is relatively limited in its scope; hence those that are wrong are counterbalanced by those that are right. The decision of any single individual or of any small group is not so far-reaching in its effect as to endanger the welfare of the entire nation. On the other hand, the decisions of a national economic planning board, if wrong, would have devastating effects on the people as a whole, since no countervailing influence would be available, all economic power being lodged in the central government.

James Madison said at the time the Constitution was under discussion, "The economic foundation of the American Political system is the protection of the differing and unequal capacity of men to acquire and use property," Hence, the men who wrote the Constitution took great pains to curtail the powers of the Federal government in the economic sphere by limiting its business activities to such matters as controlling the national currency, running the public posts, and regulating commerce between the several states and with foreign countries. They had immediate knowledge of what government control of private business had meant in France where, for example, in the years preceding our own Revolution, it required a dozen or more quarto volumes to set forth the rules and regulations governing the weaving of textiles alone! As de Tocqueville, the historian, said of that period: "New rules followed each other with such bewildering rapidity that its agents never knew which to obey of the multifarious commands they received." How familiar that sounds in this year of our Lord 1942!

Every decade, until the last, showed a continuous increase in the national wealth of the United States and in our general standard of living. Only in the past ten years has our living standard actually declined. Whatever its faults, the American system produced the highest degree of prosperity for the greatest number of people that any nation has ever enjoyed in the world's history. The iconoclasts in our midst—those who for the past twenty years have been bowing down and worshiping at the altars of communism, socialism and fascism—have effectively deprecated our national achievements, not only in respect to physical well-being but also in regard to our remarkable progress in the fields of education, philanthropy and the fine arts. So today many Americans have actually lost faith in our free institutions and have permitted the economic plight of the unfortunate minor fraction of our population to blind them to the incomparable record that has been attained for the nation as a whole. According to the official figures of the U. S. Department of Labor, average hourly earnings increased from "20.7 cents in 1909 to 66.1 cents in 1939. The average worker had about 2-1/3 hours more leisure per working day in 1939 than in 1909. At the same time, in terms of things the dollar could buy, for every dollar the average weekly pay envelope contained in 1909, it had $1.47 in 1939."

But why recite more statistics: As the men who founded this Republic look down from their celestial abode, they might well repeat the epitaph of Sir Christopher Wren—the architect of St. Paul's Cathedral in London who lies buried in its crypt: *Si monumentum requiris, circumspice.* "If you seek

my monument, look about you." Yes, if you seek the results of their work, look about you: At our churches and hospitals and asylums; at our museums and libraries; at our marvelous system of public and private education; at our community chests and private philanthropies; at the innumerable comforts, conveniences and luxuries that have made America the envy of all mankind.

If liberty is to be preserved in America, we business men have a definite responsibility to discharge. We must be shining examples of civic virtue, using that phrase in its classic sense. We must eliminate unethical practices in our own enterprises so that business can always come into the court of public opinion with clean hands; we must be keenly conscious of the social significance of our day by day decisions; we must be good stewards of the responsibilities with which individual freedom has entrusted us; we must steadily seek ways and means of regularizing employment and cushioning the effect of advancing technology on the lives and fortunes of our workers; we must raise the standard of living by passing along the benefits of improved technique and quantity production through lower prices and higher wages; we must constantly endeavor to create better conditions of employment by the elimination of health and accident hazards; we must take an active part in public affairs; we must seek to be economic statesmen rather than mere business men.

All of us live today in the shadow of war. We live to see helpless civilian populations blotted out as death rains from the sky. We live to see the sanctity of treaties and contracts violated at the caprice of wilful men. We live to see the culture and art of nations degraded by the sort of tyranny and cruelty that characterized the Dark Ages. We live to see old symbols of honesty, sincerity and character mutilated under the heel of brutal military power. In the midst of such chaos, when moral and intellectual ideals are obscured and stained with crass selfishness and overweening ambition; when bewildered peoples eagerly grasp at the tenuous straws of alleged economic security offered by strongly centralized governments; when those who sit in the seats of power are themselves confused and distraught; when, as Emerson said, "Things sit in the saddle and ride men," America must turn again to the root principles of her liberty for national salvation.

The good seed our fathers planted must be sown and resown, and the tares of alien theories and subversive philosophies weeded out of our national life. Our schools must again take delight in teaching the old-fashioned patriotism, sacrifice and civic virtue of our national heroes. Our colleges and universities must again stress, as they did in former days, the philosophic and religious concepts on which the American Republic was founded. For while the mechanics of government change, the root principles on which men can associate themselves permanently to maintain the blessings of popular self-government are immutable and eternal. Our churches must continue to sound the clarion note of personal moral responsibility, of the sacredness of human personality, of the transcendent importance of character. As Woodrow Wilson said: "Democracy is conduct and its only stable foundation is character."

The perpetuation of our type of national life demands more intelligent interest, more personal effort, more continual sacrifice, more true patriotism than any other form of government. Selfishness, cynicism, complacency, the natural human desire to seek escape from present realities in the wish fancy of a brighter day to come, will bring their own grim and inevitable reward. "The mills of the gods grind slowly but they grind exceeding small." How easy but how fatal it is for us to say:

Let me forget—Let me forget
I am weary of remembrance,
And my brow is ever wet,
With tears of my remembrance,
With the tears and bloody sweat,—
Let me forget.

If ye forget—If ye forget,
Then your children must remember,
And their brow be ever wet,
With the tears of their remembrance,
With the tears and bloody sweat,—
If ye forget.

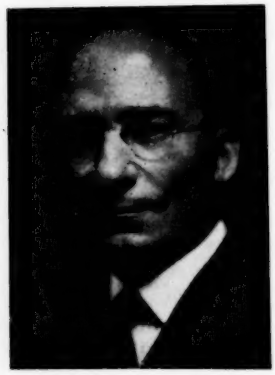
WPA Airport Construction

WPA Commissioner Hunter recently announced WPA workers had improved facilities at 887 airports at the end of 1941, including 533 completed projects. He said 76 additional projects also had been approved for construction. On December 31, 61,000 WPA workers were employed on 354 airport projects, he said, and WPA expenditures on the entire program reached $450,000,000. Current WPA work represents a great part of all wartime airport construction and comprises, almost without exception, projects for the Army and Navy or civilian projects certified to be of military importance, he said. The WPA has constructed 700 miles of runway and over 1,000 airport buildings and has enlarged or improved 2,700 buildings, he said.

And Now, What of Research?[1]

By A. T. GOLDBECK
Engineering Director,
National Crushed Stone Association

• Suddenly our economy has shifted from a partial to an all out war time basis. What part can our Association play? How can it help? To what extent is the Association needed under present conditions? Every crushed stone producer should read Mr. Goldbeck's informative discussion of these basically important questions.



LAST year at this time we were pursuing our peaceful ways of living with only a slight uneasiness for the future. Suddenly we were plunged into a conflict whose difficulties are still unknown and whose ramifications will affect our lives in ways which are now little more than conjecture. We know only that we are due for drastic changes in our personal existences and in our business activities.

What part should we and can we, as an Association, play in this rapidly growing emergency, which best will serve the needs of our country? I hope there will be no dissent on the part of anyone from the idea that right now there is no more important job for individuals and for organizations such as ours than to exert every effort, in ways for which we are best suited, to the end that our country will win this dastardly conflict as expeditiously and as decisively as possible. There is no job in the world of greater importance to us than that and the sooner we all realize that fact, the quicker shall we be able to resume more normal ways of living. Each individual can and should steer his course for the public good in this emergency. That course, for many individuals, may consist merely in more intensively and more conscientiously pursuing their regular duties, for, after all, many normal activities must go on even though geared higher to a war economy. For many other individuals, however, an entire change in activities is surely indicated and will be demanded during this emergency.

The crushed stone industry is a basic industry which must continue to operate, for its products are needed in war activities of many different kinds. We see a rapid expansion in our defense equipment and much of this expansion makes our products vital and essential. Thus, our new munitions plants and factories, our fortifications and harbor improvement works, our army depots and dry docks, our gun emplacements, our strategic highways, our enlarged steel production and even our intensified agriculture, all require our stone products in one form or another. This vital emergency work cannot go on without crushed stone. We are necessary to our country's existence in war as well as in peace. In many plants we must produce with greatly intensified effort.

Then, too, this vital nature of our products requires increased negotiation and cooperation with those agencies which are using them for one purpose or another. These are governmental agencies for the most part and already they have found it expeditious to put some of their problems up to your national association to solve as quickly as possible. These problems will probably increase in number and importance as the war effort becomes intensified. Thus, you and your association occupy an important place in this unwanted, but very necessary war economy. Thus, also, many of your association's activities are more important now than ever before and to these activities others undoubtedly will be added.

In not too much detail let us look at a few of these defense and allied problems in which our association's engineering force has already played a part.

Airport Runway Design

The development of air offense and defense is now recognized as one of the very highest importance to all branches of our armed forces. Airports and airplane manufacturing industries are springing up all over the country. Airplane loads have increased by leaps and bounds. A 40,000 pound wheel load is very common and at least one plane weighs 80 tons, with a wheel load of 80,000 pounds supported on a single tire 8 feet in diameter and 3 feet wide. This is eight times the normal maximum wheel load on our highways. The soils upon which airports must be built vary as widely as soils can vary, from those of a highly plastic nature, to highly stable granular ma-

1 Presented before the annual convention Cincinnati, Ohio, February 2, 1942.

terials, from those which are susceptible to drainage to those which are not.

A designer of runways for airports is confronted with an even more difficult task than the designer of highways, for he is dealing with tremendously heavy loads, moving with great rapidity and supported by the runways through the medium of low pressure tires which act in an unknown way.

Since our Association is a national organization and our material is nationally available for airport construction, we have considered it as our duty to contribute all we could to the solution of this national engineering problem of airport design. We started on this problem in our laboratory some two years ago for we predicted a rapid expansion of air travel. Fortunately, we were not without experience in this field of research in design and after a considerable amount of painstaking work in the laboratory, we succeeded in evolving a method for determining the thickness of runways required to support airplane wheel loads of any magnitude and on any size of tire. We concluded that this was a problem that should be solved without delay with as much nicety as seemed necessary, but with due recognition of the probable impossibility of ever arriving at a truly rational design method. Our own method has attracted a great deal of interest and thus far in practice it has not been proven to be incorrect. We regard such work as this as being of high importance in our contribution to the national effort and incidentally we believe it demonstrates the extreme desire of our industry to cooperate in solving those problems which will be of benefit nationally. The details of our solution of airport runway design for the flexible type of road appeared in the August-October, 1940, issue of the CRUSHED STONE JOURNAL and it also was published in reprint form.

Concrete for Dry Dock Construction

At present a number of dry docks are under construction. They are of huge proportions and they are being built under a number of different circumstances. In some cases the concrete will be deposited by means of tremies under water. Imagine, if you will, a structure some 1200 feet long, 150 feet wide, with concrete sidewalls some 20 feet thick and a base of like thickness. This entire base and a large part of the side walls may be deposited under water and, as you can well imagine, some very nice problems of concrete proportioning are thereby created which require some very careful laboratory studies to ensure that the correct proportions are used for any given set of aggregates. Above all, the concrete must be extremely workable, so that it will be capable of flowing under water with as little disturbance as possible

It fell to our lot to work on the problem of determining the proper proportions for stone concrete to be used under the above described circumstances. This immediately necessitated the use of some kind of a device for measuring workability. Such a device was developed in our laboratory a number of years ago. It consists of a vibrating table upon which is mounted a beam mold which we transformed into a workability measuring apparatus by the expedient of mounting at one end of it a prism mold into which our concrete was placed. We then started the vibration apparatus in motion and allowed the concrete to flow through an orifice from the vertical prism mold to the horizontal beam mold. Thus, the concrete was forced to change its shape and the time required for this remolding operation was taken as a measure of workability, the longer the time required the less workable was the concrete.

I shall not bother you with the details of our investigations, but suffice it to say that, as a result of rather elaborate tests, we were able to demonstrate that, with the stone which was available for certain of these dry docks, concrete could be produced of sufficient workability for the purpose and also with high strengths, using an amount of mixing water not in excess of specification requirements. We were able to suggest specifications for the stone and for the concrete for use in this dry dock work. And the engineers seemed to be very thoroughly convinced that it would be practicable for them to use crushed stone for this purpose, notwithstanding the extreme workability required in the tremie concrete to be employed. Again, this was a contribution to the national effort and incidentally should help stone producers when the proper time arrives.

Highway Research Board Conferences

As you have been informed in past years, our association has always believed in contributing to the activities of national technical bodies such as the American Society for Testing Materials, the Highway Research Board, the American Concrete Institute and others. During the past year we have continued our contributions to these bodies and, among others, I should like to note especially two conferences held by the Highway Research Board, one on airport design and the other, on the question of how to increase durability of concrete.

These conferences were attended by different groups of individuals. The subjects were widely different, the airport conference being comprised of a large group of engineers from the different governmental branches having to do with airport design and also of a number of other individuals who might contribute their knowledge of soils and highway design to our immediate problem. This conference was largely a matter of pooling our knowledge of the subject to the end that needed investigations for clarifying doubtful points might be undertaken and so that final conclusions might be arrived at as quickly as possible while airports are being constructed and not after they have become completed. The past work of our association enabled us to contribute to this conference. Thus, again, we were able to help in a national way.

During the past year, also, the Highway Research Board held a conference on the Durability of Concrete. Concrete structures when exposed to the weather, for one reason or another, have not shown the high durability that was expected of them. A number of different causes for lack of durability have been advanced. A complete discussion of this subject could not be made within a period lasting many days, let alone within the few minutes now available. Among the causes are such matters as unfavorable proportioning of the concrete, primarily the use of too much water, unsuitable cement compositions and unsound aggregates which will not withstand freezing and thawing. Certain chemical effects have been advanced as causes, such, as the combination of excessive alkalies in the cement with certain types of silica in the coarse aggregate. High thermal expansion is a cause and likewise the production of disruptive internal stress due to rapid changes in temperature. Freezing is a potent factor in producing weathering of concrete as well as of rocks in the earth's surface. All of these matters were discussed in great detail, together with methods of testing to determine their influence and, if possible, ways to eliminate their bad influence. This step, as you will recognize, is really one for the national good, a step in which our Association should be proud to lend its aid.

Concrete Proportioning

During the past year we have been engaged in laboratory investigations having to do with the effect of the coarse aggregate on concrete proportions. As you can readily understand, the method of proportioning concrete to perform a given service might play a very great part in the question of competition of aggregates. If the concrete is proportioned in one way under a given theory, competition as between classes of aggregates may be economically possible. On the other hand, if another theory is used which results in somewhat different proportions, it becomes almost a foregone conclusion that one type of aggregate will be used to the exclusion of the other and unfortunately crushed stone is frequently that "other" type. You can well recognize the importance, therefore, of our engaging in investigations to determine the real truth of this matter of the correct proportioning of concrete.

There has grown up in this country, as a result of the water-cement compressive strength relationship announced by the Portland Cement Association years ago, a theory for concrete proportioning which has done harm to the crushed stone industry. This theory lays great stress on the importance of using as dry a paste and as little of it as possible, consistent with obtaining the necessary plasticity and workability. Since fragments of round aggregates can be moved with respect to one another more easily than those of angular aggregates and since also the voids are less in the round aggregates, it is inevitable under this theory that gravel concrete will require less cement paste of a definite water content than crushed stone concrete.

The constant water-cement ratio theory of concrete proportioning considers the density and strength of the cementing medium as all important and it omits from consideration the effect which aggregate characteristics may have after the concrete has hardened. These effects may and often do affect the durability and strength of the concrete to so great an extent as to make the influence of the cement paste one of minor importance. Among the durability influencing characteristics of the aggregates are roughness of surface which affects the bond strength in the course of time, thermal expansion which is very important in creating high internal stresses, absorption which may affect both bond and durability and mineralogical composition which has to do with subsequent chemical reactions which may cause crystal growth and disrupting effects. These matters are neglected by the fixed water-cement ratio method of design.

Tests which we have conducted during this past year involve a number of commercial stone and gravel concretes having a range in characteristics. The concretes were designed to have the same cement factor and consistency, hence the water-cement

ratios were variable and generally were higher in the stone concretes. These concretes were subjected to 100 cycles of freezing and thawing and the effects were noted, first in terms of loss in weight, second in terms of the permanent expansion brought about by the freezing action and third, in terms of final slab strength.

Briefly, it was outstanding that the stone concretes, having a higher water-cement ratio than the gravel concretes were not less durable. The use of a definite water-cement ratio, with its consequent effect of requiring a higher cement factor for stone concrete than for gravel concrete is not justified. As a consequence we are advocating a revision in this method of design to the extent of requiring that concrete for any given class of work be proportioned to have the same cement factor, irrespective of the coarse aggregate the same consistency and with a maximum allowable amount of water. This may result in a slightly higher water-cement ratio for stone concrete than for gravel concrete. A paper on this subject will be published shortly; we hope to the benefit of the crushed stone industry.

Bituminous Surface Treatment Experiments

During the past year a question of serious competition of crushed stone with iron ore tailings, another type of cover material for bituminous surface treatments, arose which seriously threatens the use of stone for this purpose in a given locality. Our circular track and physical tests on the materials in question have shown that iron ore tailings by no means is as suitable a material as the stone, for under the action of the rubber tired traffic and wet weather conditions, serious displacement of the tailings took place before the stone showed any signs of deterioration whatever. Furthermore, the tailings crushed more under the roller and they should behave in this manner judging by the fact that they have an abrasion loss of 35.9 per cent as against only some 23 per cent for the limestones in question.

But irrespective of the durability of these respective surfaces a very interesting question arose which might well be mentioned briefly. It is known that aggregates have different specific gravities and different shapes. A flat particle will lie flat on the surface and therefore a square yard of surface will require a smaller weight of cover stone that is very flat than will be necessary when the stone is cubical. The specific gravity also controls the amount of stone required to cover a given surface area, in direct proportion to the relative specific gravities. Furthermore, different thicknesses of stone cover will result, depending upon the amount used and the shape of the particles. Naturally, the thicker the cover, the greater will be the quantity of bituminous material which can be used without flooding the surface and thereby creating an undesirably slippery condition. This is so because of the greater volume of voids up into which the asphalt can rise before it flows over and forms a slippery sheet on the road surface. Yet these important facts are practically never recognized and it is quite common in surface treatment work to use 1/10 gal. of asphalt for each 10 pounds of stone per sq. yd. of road surface, irrespective of wide variations in weight and shape of the cover stone.

These quantities are not always correct for the reasons already stated. Too much asphalt with consequent flooding may result in one case and too little in another case with resulting raveling of the surface in spots. We have been endeavoring to arrive at a universal rule which will permit of quickly determining the proper amount of cover stone and the proper amount of asphalt to use with it.

I conceive it as a part of our duties to attempt to develop information of this character for the improvement of the bituminous surface treatment type of road construction in which crushed stone is so widely used. This is another illustration of an effort to improve road construction for the general good of all stone producers and road users as well.

Critical Materials Survey of the Crushed Stone Industry

In two different instances, divisions of the Office of Production Management have requested us to get information for them in a very short interval of time regarding the probable requirements of our industry for critical materials during the coming year. We assisted in preparing the inquiries which were addressed to the industry and the results were analyzed by our engineering staff. As you know, it is now extremely difficult to get some materials and some equipment to properly conduct your operations and these critical materials will be allocated to industry in accordance with what seems to be the relative importance of the individual operations to the war economy. We succeeded in giving the OPM an answer to their inquiries within the very short time allotted to us for this purpose. You may be interested to know something of our findings.

Briefly, we estimated that 195,000,000 tons which includes non-commercial as well as commercial stone

and includes rip rap, crushed stone, furnace stone, agricultural limestone and other uses, were produced in 1941 and will probably be produced in 1942. We recognize that our 1942 estimate is uncertain.

Apparently, for this production there will be required 70,970 tons of metal made up of ferrous and non-ferrous metal for replacement parts and other metal exclusive of that in new machinery. This amounts to 0.73 pounds of metal per ton of stone produced. In addition, we estimate that there will be required 18,800 tons of metal in the form of new machinery. This amounts to 0.19 lb. of metal per ton of stone produced.

All told, therefore, our metal requirements per ton of stone are as follows:

Raw metal and replacement parts	0.73
New machinery	0.19
Total	0.92 lb. of metal per ton of stone produced.

Our report classified this metal as nearly as possible into a number of different steel alloys, castings, plates, non-ferrous metals, etc.

Rubber requirements were also included as well as a number of other materials such as oxygen and acetylene for welding.

Hardly a day goes by that does not require us to utilize the past work of our Association to overcoming some difficulty or to emphasize or demonstrate some important point. We frequently are called on to help individual members of the industry in ways which differ as the circumstances may require. Thus, conferences with Governmental agencies have been had on specifications for airports, a bomb-loading plant, an army depot, dry docks and other defense works, a water supply dam, highways and other structures. Most of these conferences are supplemented by correspondence and in some cases by necessary laboratory tests. Statistical work in connection with our war economy may only be beginning. Our engineering force is well acquainted with the work of that nature. Our experience dates back to the days of the N. R. A. and we have had additional practice in the meantime.

Conclusion

Yes, your Association seems to be needed now more than ever. We have been doing defense work and started cooperating in the national effort even before the necessity for such an effort was generally recognized. We think you will be glad to know that your Association has been called upon to help, that it already has given substantial help and that it stands ready to give further assistance to the limits of its capabilities. Can there be any doubt in the light of the past year's record as to what is the answer to the question propounded in the title, "And Now, What of Research?" The record reveals only one answer: Research is needed now even more than in peaceful times.

Flight Strips to Serve Entire Country

THE Federal Government has started construction of flight strips that will provide the entire country with auxiliary landing areas, Lt. Col. S. S. Hanks of the Army Air Forces told the Association of Highway Officials of the north Atlantic States in Philadelphia. The program will be carried out by the Public Roads Administration, in cooperation with the Army Air Forces. Col. Hanks, originator of the "Hanks Plan," has been designated head of the Flight Strips Unit set up within the Army Air Forces.

Flight strips are vitally needed to "furnish dispersal points for aircraft, to alleviate the crowding of our main air bases and lessen the risk of large-scale bombing losses caused by excessive concentration of aircraft," and to provide hopping-off points for flight planes defending the nation's coast lines, Col. Hanks said. He announced several foreign countries are cooperating in the program to provide support around existing airports and otherwise bolster flying routes to American defense outposts. He said these strips will be important to commercial aviation after the war because "they will provide landing facilities for commercial feeder airlines connecting points not now served by airlines, and safe refuge for planes of all types forced down by weather or mechanical difficulties."

He said utmost caution must be used in safeguarding their location, but in many instances it will be determined "by the nature of anticipated attack and location of the theatres of operation." Construction of flight strips will involve in most instances little more than widening of highway rights-of-way or use of roadside development areas and establishment of a definite line of demarcation between the highway and the strip. The runway will be 3,000 to 8,000 feet, depending on elevation of the ground and type of aircraft for which it will be used. The actual runway may not be more than 150 feet wide, with a minimum cleared width of 300 feet.

Developments in Asphalt Pavement Construction[1]

By BERNARD E. GRAY
Chief Engineer, The Asphalt Institute
New York City

• **Methods of both mixing and laying bituminous paving gradually change. New equipment is developed; new ideas as to appropriate asphaltic materials for different purposes are being evolved. It is important that stone producers engaged in the bituminous paving industry keep abreast of these advancements. Mr. Gray, in his capacity of Chief Engineer of the Asphalt Institute, is excellently qualified to bring us up to date as to the progress in the various phases of the asphalt industry.**

IT IS a pleasure to be here today in celebrating the Silver Anniversary of your organization. As never before, industry groups like our own are essential in carrying on the research and engineering which are the distinguishing characteristics of American life. Through their activities, improved technique and lower costs have resulted, and we can take a rightful pride in the fact of our contribution to improved living conditions in peace, and our ability to quickly mobilize resources in aiding Government in time of war. Your engineering director, Albert Goldbeck, is a friend of many years' standing, and I do not need to comment on the high position which he holds in both engineering and industrial circles. Your presiding officer and I have visited many a job and talked far into the night on how we could better an already good way of surfacing. Similarly, many others of this group have been my friends during the past twenty-five years and even for some years before. And so by way of introduction, I congratulate the National Crushed Stone Association on its quarter century of highly useful activities, and wish for its officers and members many equally successful anniversaries in the future.

In looking over the subject which has been assigned to me for this meeting, I cannot help but be impressed by the cycle of events which has taken place in the pavement industry during the past 30 years. At the beginning of that period, the usual type of pavement for state highways was waterbound macadam, and those of us who were building roads in that era will recall the great detail in respect to specifications. One item in particular was in regard to proper filling of the voids with grout in such a way that they would be completely filled and the maximum stability of the surface obtained. There often was a difference of opinion as to the amount of water to be employed, and one group insisted that voids be filled with dry screenings before any water was used at all. Agreement was unanimous, however, in regard to a good foundation, and a road would be constructed with an unusually heavy sub-base to meet particular heavy loading conditions.

In the years since, have come all kinds of both flexible and rigid types of pavement, and for a time there was the impression that by building a massive rigid pavement, necessity for taking care of subgrade could be avoided, and that a bad subgrade could be covered in a satisfactory manner with pavement alone. Of course we know now that no greater fallacy ever prevailed than the notion that a good pavement would make up for a bad foundation. Certain inherent qualities must be had in a road bed, the principal one being ability to undergo temperature and moisture changes with little or no volume change. If the natural soil does not possess this quality, then it must be altered, either by suitable treatment or else blanketed with a layer of new material which has this property. The intensive studies in soil mechanics are now bearing fruit in the form of definite technique for building subgrades and foundations which will have the desired quality.

The "Engineered" Subgrade-Foundation

For want of a better word, I am using the term "engineered" subgrade-foundation, because when a foundation has been correctly designed, the surface becomes a secondary problem. In regard to subgrade support, considerable attention in recent years has been given to so-called "soil stabilization" processes,

[1] Presented at the Twenty-Fifth Annual Convention of the National Crushed Stone Association at Cincinnati, Ohio, February 4, 1942.

but I believe that as a result of the various experiments which have been made in this field, the conclusion is inevitable that wherever mineral aggregates are cheaply available, the best procedure is the mechanical form of stabilization. Our present aggregate production equipment is so substantial and so widespread that the engineer should first consider the use of these products by themselves in the required thickness rather than to construct a thinner section requiring outside commercial binders.

In the use of crushed stone, a rather wide variety of foundation processes is possible. First there are the standard methods of constructing stone base which are well established. These are particularly applicable where long experience in the technique of doing this work has been had. However, under present circumstances where great haste is required and where construction must be done under adverse weather conditions, these methods are not always as satisfactory as might be desired. The rutted condition of the subgrade with alternate freezing and thawing sometimes makes the use of coarse aggregate and screenings (either with the drybound or waterbound method) a less certain procedure, and the alternate method of mixing mineral aggregate bases at optimum moisture content, which can be immediately consolidated to the ultimate dense condition, is worthy of consideration.

A number of gradations are possible, but in Table I are shown four different ones which permit a rather wide range of aggregate sizes and yet which require processed materials as a general rule. An even coarser gradation than the one shown in the table may be employed, the basic idea being to obtain maximum density, and yet with such tolerances as will permit most economical use of quarry products. In many instances, there are substantial stock piles of material which may be reworked to produce one of these gradations, either alone or in conjunction with current output.

TABLE I

Sieve Designation	Percentage by weight passing square mesh sieves (A.A.S.H.O.T-27)			
	Grading A-2	Grading B-2	Grading C-2	Grading D-2
3-inch	100			
2-inch	65 - 100	100		
1-½-inch		70 - 100	100	
1-inch	45 - 75	55 - 85	70 - 100	100
¾-inch		50 - 80	60 - 90	70 - 100
⅜-inch	30 - 60	40 - 70	45 - 75	50 - 80
No. 4	25 - 50	30 - 60	30 - 60	35 - 65
No. 10	20 - 40	20 - 50	20 - 50	25 - 50
No. 40	10 - 25	10 - 30	10 - 30	15 - 30
No. 200	3 - 10	5 - 15	5 - 15	5 - 15

The principal difficulty with certain pavement designs is the abrupt change between the subgrade and the pavement proper. This is particularly marked with rigid types of pavement but also manifests itself with various types of bituminous pavement when laid directly upon the raw earth subgrade. It is highly desirable to have a transition layer which can react more nearly like the subgrade under changing moisture and temperature conditions and yet which will not suffer from cracking. When this layer has all of the desirable support qualities, the problem of paving becomes one only of providing necessary resistance to abrasion plus waterproofing of the mineral aggregate foundation below. The cost of constructing such foundations in appropriate thicknesses to provide the necessary bearing power, together with the bituminous pavement required for surfacing, is much less than for a massive pavement alone, and in addition has qualities of durability, strength, and smoothness which cannot be surpassed by any other method. Recognition of this basic principle is becoming widespread and I have no hesitancy in saying that this type of construction, whether for a light duty road or for the heaviest dual type highway, will come to be the standard method on the greater proportion of all highways and airports.

I have laid this emphasis on the construction of mineral aggregate foundations, because I think it is the most important development of the present day, and because its economy and engineering qualities are so evident that acceptance of the procedure is certain. We have always known that these stone foundations were durable, but frequently non-uniform areas resulted, usually because of uneven compaction. Control of gradation and moisture insures immediate compaction to ultimate condition. More and more the construction of these bases will employ plant-mixing methods, and transit mixers, drum mixers and pug mixers will all be used for the purpose. Crushed rock is cheaper than commercial binders and often it is possible to double or triple the thickness of the aggregate foundation and reduce the thickness of the wearing course with no increased total cost, and yet with large increase in durability.

Now by this time you are probably wondering whether I am in the stone business or selling asphalt. However, I am not completely altruistic, but rather I am convinced that no promotion, no matter how skillful or how vigorous, will sustain a method in the long run which is not economical. With the present trend in paving design, I prefer to see foundations constructed with materials which are immediately

at hand and which require the minimum of transportation and handling. So long as there are thousands of miles of highway in this country which require construction and reconstruction, and with thousands of airports which must be built to take care of the enormous flock of new airplanes, the asphalt industry will be very busy in providing the required surfaces over these mineral aggregate foundations.

In connection with the matter of economy, many states must now give this item far more consideration than has been the case in the past. The enforced curtailment in use of the automobile will have a tremendous effect upon the fiscal policy of state and county departments. Now that it has been so thoroughly demonstrated that these properly constructed flexible types of pavement have all requisite bearing power and durability, the substantial savings obtained from such designs no longer can be overlooked. This has been strikingly illustrated only last week in one of our Mid-Atlantic states, where on one of the heaviest traveled access roads, the following design was adopted:

3″ waterbound macadam sub-base
3″ asphalt penetration macadam base
4″ hot-mix asphaltic concrete surface

The cost of this 10″ pavement was $1.90 per square yard. Does anyone doubt the quality of such a design, or that it will serve for many years without cracking, without joints, and with nominal maintenance?

Simplified Practice

The Asphalt Institute is now engaged in revising all of its specifications. As a member of the committee on Simplified Practice, I have been completely in favor of adopting Recommendation R 163-39 at the earliest possible time. The only reason for the apparent lag between the promulgation of the Simplified Practice and its adoption by The Asphalt Institute has been the inescapable delay pending final approval of our Technical Committee. This considerable work of revision has now been completed and the new specifications will be ready in the near future. It may be of interest to this group to know the several sizes which have been adopted for different classes of asphalt work and they are shown in the following Table II.

As examples of the manner of showing gradations and composition of mixtures, Tables III and IV are given for coarse graded asphaltic concrete surface and base courses.

TABLE II

SIZES OF AGGREGATE RECOMMENDED IN ASPHALT INSTITUTE SPECIFICATIONS

	Simplified Practice Designation		
	Coarse	Medium	Fine
TYPE PAVEMENT (A. I. Designation)			
Asphalt Penetration Macadam Specification A-1, Surface Course	No. 3 Alternate No. 2	----	No. 67
Asphalt Penetration Macadam Specification B-7, Base Course	No. 3 Alt. No. 2	----	No. 67
Hot-Mix Asphaltic Concrete Specification A-2, Surface Course	No. 5 Alt. No. 68	No. 8 for Seal Coat	----
Hot-Mix Asphaltic Concrete Specification B-8, Base Course	No. 467 Alt. No. 357	----	----
Stone Filled Sheet Asphalt Specification A-3, Surface Course	No. 8	----	----
Sheet Asphalt (Binder Course) Specification A-4	No. 67	----	----
Cold Laid Plant-Mix Specification CL-1	No. 5	No. 68	ASTM C33-39
Cold Laid Plant-Mix Specification CL-2	No. 5	No. 68	No. 7
Cold Patch Specification B-6 patches less than 1½″ patches over 1½″	No. 6 No. 357	----	----
Road-Mix Specification RM-1	No. 5	----	No. 7
Surface Treatments Specification S-1 RC-cutback asphalts	Alternates No. 7 No. 9 No. 79	----	----
Surface Treatments Specification S-2 RC-cutback asphalts	No. 7 No. 6 No. 67	----	----
Surface Treatments Specification S-3 MC-cutback asphalts	No. 8	----	----
Surface Treatments Specification S-4 Emulsified asphalts	No. 7	----	----
Surface Treatments Specification S-5 Emulsified asphalts	No. 67 No. 9 No. 8	----	----
Modified Penetration Specification MP-1 Emulsified asphalts	No. 4 No. 5 No. 6 No. 67 No. 79 No. 8 No. 9	----	----

N. B. Under surface treatments and modified penetration, size of aggregate decreases as viscosity of asphalt decreases.

TABLE III

MATERIALS FOR HOT-MIX PAVEMENTS

ASPHALT INSTITUTE SPEC. A-2—ASPHALTIC CONCRETE SURFACE COURSE

Coarse Aggregate

GRADING REQUIREMENTS
(Simplified Practice No. 5)

Per Cent Passing 1½" sieve	100
" " " 1" "	90-100
" " " ¾" "	40-75
" " " ½" "	15-35
" " " ⅜" "	0-15
" " " No. 4 "	0-5

Fine Aggregate (sand)

GRADING REQUIREMENTS

Passing	Retained on	Per Cent
No. 4 sieve		98-100
No. 4 "	No. 10 sieve	8-25
No. 10 "	No. 40 "	15-50
No. 40 "	No. 80 "	22-65
No. 80 "	No. 200 "	7-40
No. 200 "		0-8

Mineral Filler

GRADING REQUIREMENTS

Per cent passing No. 30 sieve	100
" " " No. 100 "	85+
" " " No. 200 "	65+

Asphalt Cement 70-85, 85-100, 100-120 or 120-150 Penetration

MIX REQUIREMENTS

Mix			Per Cent
Passing 1½"	retained on 1"	sieve	0-5
" 1"	" " ¾"	sieve	15-25
" ¾"	" " No. 4	sieve	20-35
" No. 4	" " No. 10	sieve	5-15
" No. 10	" " No. 200	sieve	25-35
" No. 200 sieve			4-6
Bitumen (soluble in carbon disulphide)			5-8
% Voids in compacted mix			5 –

Alternate Coarse Aggregate

GRADING REQUIREMENTS
(Simplified Practice No. 68)

Per Cent passing 1" sieve	100
" " " ¾" "	90-100
" " " ⅜" "	30-65
" " " No. 4 "	5-25
" " " No. 8 "	0-5

Alternate Mix

MIX REQUIREMENTS

			Per Cent
Passing 1"	retained on ¾"	sieve	0-5
" ¾"	" " ⅜"	"	15-25
" ⅜"	" " No. 4	"	20-35
" No. 4	" " No. 10	"	10-25
" No. 10	" " No. 200	"	25-40
" No. 200 sieve			4-10
Bitumen (soluble in carbon disulphide)			6-9
% Voids in compacted mix			5 –

TABLE IV

ASPHALT INSTITUTE SPEC. B-8—ASPHALTIC CONCRETE BASE COURSE

Coarse Aggregate

GRADING REQUIREMENTS
(Simplified Practice No. 467)

Per Cent passing 2" sieve	100
" " " 1½" "	95-100
" " " ¾" "	35-70
" " " ⅜" "	10-30
" " " No.4 "	0-5

Fine Aggregate (sand)

GRADING REQUIREMENTS

Passing	Retained on	Per Cent
No. 4 sieve		98-100
No. 4 "	No. 10 sieve	8-25
No. 10 "	No. 40 "	15-50
No. 40 "	No. 80 "	22-65
No. 80 "	No. 200 "	7-40
No. 200 "		0-8

Asphalt Cement 70-85, 85-100, 100-120 or 120-150 Penetration

MIX REQUIREMENTS

Mix			Per Cent
Passing 2"	retained on 1½"	sieve	0-5
" 1½"	" " ¾"	"	20-30
" ¾"	" " No. 4	"	25-40
" No. 4	" " No. 10	"	5-15
" No. 10 sieve			20-35
Bitumen (soluble in carbon disulphide)			4-7

Alternate Coarse Aggregate

GRADING REQUIREMENTS
(Simplified Practice No. 357)

Per Cent passing 2½" sieve	100
" " " 2" "	95-100
" " " 1" "	35-70
" " " ½" "	10-30
" " " No. 4 "	0-5

MIX REQUIREMENTS

Mix			Per Cent
Passing 2½"	retained on 2"	sieve	0-5
" 2"	" " 1"	"	20-30
" 1"	" " No. 4	"	25-40
" No. 4	" " No. 10	"	5-15
" No. 10 sieve			20-35
Bitumen (soluble in carbon disulphide)			4-7

The Institute will urge upon all agencies the adoption of these gradations, which should result not only in more uniform and more economical work, but also lead to improvements in technique as the variable of aggregate variation is eliminated.

The Design of Asphalt Mixtures

Changing traffic and equipment conditions have had their effect upon the design of asphalt mixtures. The change of traffic has been remarkable indeed and where several years ago under solid and cord tires we had an annealing action and a trend toward

coarser textured surfaces in the endeavor to anticipate such action, we now have under the balloon tire a tearing-up effect with the present trend toward dense surfaces. Except in limited areas where solid-tired trucks make up a large percentage of traffic, the texture of a road surface now will remain substantially in the condition originally constructed. It will be noted even on sheet asphalt pavements on most city streets that the aggregate is exposed very quickly after a few weeks' wear. Incidentally, the problem of shoving which used to be encountered in certain types of asphalt surface is now practically unknown and the problem is rather to prevent cracking.

We have therefore a number of changes in design procedure which have been brought about by this change in traffic. The most important is in connection with the character of the asphalt cement. For penetration macadam, we still recommend 85-100 for main highways while for airports we recommend 100-120. However, for asphaltic concrete, it is recommended that 70-85 be employed on heavy duty city streets, 85-100 for main highways outside of cities, and 120-150 for airport surfaces. These are softer grades than formerly employed, and there is still reluctance on the part of some engineers to use them. Let me assure this group, however, that such changes are greatly to be desired, and that no danger of a soft pavement is present.

New equipment for construction of asphalt pavements has become widely available. Mixing equipment has been improved greatly, while mechanical spreading and finishing is becoming standard practice, even in cities. This new equipment, however, necessitates certain changes in design and construction technique.

(a) *Asphalt Mixing Plants*—Several new types of stationary mixing plants have come on the market. As is always the case, some discussion has arisen as to the respective merits of the old and the new. However, the real criterion of merit for any equipment is the kind of end product it turns out. Certain tolerances in respect to the end product are set up as necessary for a given condition. Provided a plant will turn out mixtures within these tolerances, it should be accepted as equal to any other type of equipment, old or new, and specifications, if necessary, should be modified to permit its use after a period of time during which its adequacy has been thoroughly demonstrated.

(b) *Spreaders and Finishers*—The spreading of asphaltic mixtures by mechanical means is now general on rural highways and airports. The present shortage of labor undoubtedly will hasten the more rapid adoption of such equipment in cities where some opposition to its use has been previously encountered. From experience gained in the use of finishing machines, the following changes in construction specifications appear desirable:

(1) Mixtures do not need to be heated as hot as with hand finishing, for the interval between the truck and the roller is so short that very little cooling of the mixture occurs. Temperatures between 225 and 275°F. are sufficient, and neither the aggregate nor the asphalt should be heated above the degree at which intimate mixing in plant and ready placement on the road can be obtained. If this can be accomplished at a temperature of 225° there is absolutely no reason for higher heating. Attention to this item will save heating costs and will expedite compaction. In addition, with fine graded mixtures, if placed by machine at the higher temperatures required for hand work, there may be migration of the fluid asphalt cement to the surface under the action of the screed which will give an over-richness to the upper inch of pavement. This is unlikely to occur with coarse graded asphaltic concrete, but it may occur with Topeka types and sheet asphalt. Several instances of this kind have been noted but by simply dropping the heat to a lower temperature, the phenomena entirely disappears.

(2) Somewhat coarser aggregate gradations can be handled with machine finishing because segregation is reduced to a minimum. Coarse aggregate mixtures are easier to spread and compact than sheet mixtures; hence there is a definite trend to their increased use even on city streets.

(3) With the use of finishing equipment, there is less rolling required and hence limitation on number of square yards per roller has been eliminated from our new specifications, and provision for periodic determination of density has been substituted instead.

Immediate Trends in Surfacing

The reduced income from the gasoline tax has been noted previously in respect to new designs. But even with the economies effected through greater use of mechanically stabilized stone foundations, there still will not be sufficient funds to reconstruct highways which are now in varying degrees of obsolescence. Just as the automobilist is now taking better care of his tires, even to the extent of patching them and nursing them along for an indefinite period,

so must the highway engineer patch and nurse along the great majority of highway miles throughout the land. The order of the day will be, "Salvage, Repair and Resurface" rather than the building of any large new mileage of replacement highways. However, this does not mean that work on the highways shall be stopped, because their unimpaired use is vital to our very existence. But it does mean that the maintenance engineer will have a bigger job than ever to keep the present road system in a high degree of efficiency. It will mean surface treatment on thousands of miles of road, and heavier surface treatments in many instances than have been carried on previously when replacement with a new pavement had been planned for an early date.

Often a road that is congested when 18′ wide becomes entirely adequate for traffic when 24′ of surface has been provided. Hence, we shall see a great deal of shoulder widening, elimination of high crown with leveling courses and with new surfaces over the widened area. Surface treatment equipment and road-mixing equipment will be utilized to the maximum in work of this kind, and of course the stone producer will be confronted with the necessity of providing necessary aggregates in such work. As a result of this heavy maintenance, many roads which appeared to be obsolete will be found not so much so as was supposed, and these heavy maintenance methods will continue to be employed in modernizing many highways where entire reconstruction previously had been thought to be the only corrective.

Summary

(1) The building of the "engineered" subgrade foundation is the most important development in present day paving practices. It is particularly important at this time when there is such a great strain upon transportation facilities. Utilization of crushed rock products available as a rule within short truck haul often will meet the need in the most economical and satisfactory manner. Upon such foundations, asphalt surfaces 2 to 5 inches thick will carry the heaviest loads.

(2) The extraordinary development of construction equipment has a marked effect upon the trend of asphalt construction. Asphalt plants are becoming widely available; they are rugged and economical and plant-mixes are becoming increasingly used for surfacing.

(3) Present new pavement construction will be limited to needed access roads serving defense areas and expanded industrial communities, together with airports. The quantities involved in airports alone are of tremendous amount. The 14 new air bases recently announced by the War Department each involve over a million square yards of pavement.

(4) For the immediate future, work on the highway system will be largely maintenance, repair and salvage. This maintenance, however, often will be of heavier character than formerly and will require large quantities of crushed stone for the purpose.

DISCUSSION

MR. GEORGE MEARIG (LeRoy Lime & Crushed Stone Corp., LeRoy, N. Y.): May I ask Mr. Hinkle a question? Of course, I understand that this isn't your paper, that it was Mr. Gray's paper that you read, but you rather slipped over any discussion of the fine aggregates used in bituminous mixes, and when you did so, you used the term "sand." Is it the opinion of the Asphalt Institute that you cannot make a satisfactory dense mix using limestone screenings for the fine particles of the mix, or did that term "sand" include both limestone screenings and natural sand?

MR. HINKLE: I am quite sure it included both, because I never heard of anybody's discriminating against the sand of limestone in making bituminous mix. In the State of Kentucky, so far as I know, in all the bituminous work done in that state and used on the state highways—I think 300,000 tons this past year—they used limestone throughout. The coarse and fine aggregate was all produced in the same quarry.

MR. MEARIG: Have they changed the specifications for fine aggregate so that the screenings from the average quarry will meet those specifications, or do they have to have an asphalt sand in order to meet the specifications?

MR. HINKLE: Those specifications for fine aggregate are given in this paper, and if I may take the time to read them, I think they are the same for all the mixes, and you will have to conclude for yourself whether or not you can make them. Fine aggregate grading, passing a No. 4 sieve, 98 to 100 per cent; passing a No. 4, retained on No. 10, 8 to 25; pass-

ing No. 10, retained on No. 40, 15 to 50; passing No. 40, retained on No. 80, 22 to 65; passing No. 80, retained on No. 200, 7 to 40; passing No. 200, 0 to 8 per cent.

MR. MEARIG: I don't know of any limestone sand that could meet that 40 to 80 specification. What was the minimum on that?

MR. HINKLE: 22 to 65.

MR. MEARIG: To my mind, that 22 would eliminate any limestone sand, if it had to meet that gradation.

I wonder if this Association would be interested at all in a specification which was designed for a limestone sand—that is, a gradation specification. My opinion is that all of the gradation specifications for fine aggregate were written around natural asphalt sands, but wherever they have used limestone sands, they have either had to add some natural sand to meet that gradation, or stay out of the picture entirely. I think it is perfectly possible to make a satisfactory mix using all limestone sand, but I think if it is possible to do that, there should be a specification drawn up for that particular type of material rather than trying to meet specifications drawn up for another kind of material. I was wondering whether anybody here felt the same way.

MR. RUSSELL RAREY (Marble Cliff Quarries Co., Columbus, Ohio): Mr. Chairman, may I make the remark that a number of years ago we encountered the same condition that you speak of, that the asphalt sand gradings were beyond the ability of stone sand people to produce, so we undertook a series of tests through Mr. Goldbeck. The test was made in three directions: one using the sand as specified and available, which was a natural sand, and against that we ran tests of stone sand of as fine grade as it was commercially possible to produce, and then he made a synthetic specimen by screening stone sand to meet the specifications of the natural sand.

The tests indicated that a practical and commercially feasible stone sand produced results beyond the specified natural sand, in stability and density and some other test he applied. That was about seven or eight years ago.

The result of that test and the use we have been able to make of it has led to the specification and the general use of stone sand in place of, or as an alternate to, natural sand, to the advantage of the pavement, in that the stone sand produced locally was very much cheaper than the fine sand and the percentage of bitumen was less and the pavement was better.

Mr. Goldbeck has those tests on our particular material, and I think the same thing would follow, because you get a stability with the stone sand in a relatively coarse grading with a reduced amount of asphalt, that it is impossible to secure with an exceptionally fine sand of rounded aggregate and a higher percentage of bitumen.

MR. MEARIG: Did you have your specifications changed? You were making that under state specifications?

MR. RAREY: Yes.

MR. MEARIG: And they changed the specifications to permit that?

MR. RAREY: That is right.

MR. MEARIG: I think that has been the case in several cities. One city with which I am familiar, the City of Rochester, made elaborate tests over the period of a year, starting with the assumption that they could not make a satisfactory dense pavement using the screenings and the gradings as they came from the crusher. They started in by separating those screenings into their different classifications and then arbitrarily setting up different percentages in each classification. When they concluded their experiments, they found that by taking the screenings as they were coming to them from the crusher, they got a pavement that was more satisfactory in every respect than they got by making any artificial arrangement of grading.

In some particular instances, it probably is the case that a state or a city has done that, but the Asphalt Institute has never done anything like that, and so far as I know, the Public Roads Administration in Washington doesn't really make any recommendations like that. I don't see why in the world there couldn't be two grading specifications set up: one for limestone screenings and the other for natural sand. I think if something was done about it nationally, if we had any trouble locally and we could point to a national specification of that kind, it might make it a lot easier for us locally.

CHAIRMAN MUNSON: I am sure that is a very fine recommendation, Mr. Mearig, and I presume, like everything else, we can dump it in Mr. Goldbeck's lap and he will certainly do a good job for us.

I can't speak for limestone, but we are making a very fine, acceptable bituminous concrete up our way, using material from ⅜" down to and through the 200 mesh. We have an excess of 200 mesh material, so that we take out perhaps 8 or 9 per cent above what we need, and we have as a residual in our bins on an average of 7 or 8 per cent of 200 mesh material. It

(*Continued on page 27*)

Adhesion of Bitumen to Aggregates[1]

By ALBERT V. BRATT

Chief of Laboratory, Massachusetts Department of Public Works, Boston, Mass.

• **Asphalt does not adhere to all aggregates equally well in the presence of water and sometimes premature failure of bituminous roads is due to this cause. Mr. Bratt has made an intensive study of this important subject and his paper, supplemented by a discussion by Mr. Boggs, should constitute a valuable contribution to the information in this field.**

CRUSHED stone is without question the fundamental material in pavement construction, and crushed stone-bitumen pavement construction has contributed more than any other type in the development of our highway system. Any factor that affects the success of crushed stone bitumen pavement is, therefore, of extreme importance. It is this fact that has brought the subject of adhesion of bitumen to aggregate into such a prominent position. There is a tendency to incorrectly assume that the investigators in this field have been spurred on by the discovery of some fundamental weakness in the stone bitumen pavement. This is not true. Your industry makes such a tremendous contribution to the road building program that any help that can be given to it is in the nature of a major effort and is in itself important. I appreciate this opportunity that your Association has given me to inform you on this subject insofar as I am able.

In order to keep this discussion of a rather complex physical chemistry problem in common terms that we understand, I have limited the scope of my paper by adopting this theme "What would I want to know about the adhesion of bitumen to aggregates if I were so fortunate as to be like you a successful and prosperous member of the crushed stone industry."

In general, I would feel that the progress my business has made, and the prosperity it may have enjoyed has been due in large measure to my ability to exercise good judgment, to my initiative and originality, and to the management that acted upon them. Consequently, I would want to know enough about the subject to enable me to continue to use my judgment, initiative, and originality in conducting my business through any changes in the use of my product that may result from the investigation of the adhesion of bitumen to aggregates.

I would want to be able to give general answers to such questions as these: What is meant by the adhesion of bitumen to aggregates? How important is it? What are the factors that govern it? What do the results of all these investigations indicate that the industry will be called upon to do? How will it affect my business? I believe it is entirely feasible for you to obtain this information, and it is the purpose of this paper to present in simple and direct language at least a part of the practical knowledge of this subject.

The logical starting point is the examination of a bitumen-crushed stone pavement. We have all seen a great many of them, but like all common things we seldom look at them carefully and almost never examine them in an analytical manner. The fundamental material is crushed stone and it constitutes over ninety per cent (90%) of the weight of the pavement. The stone is crushed because that is the most economical and practical method of handling it. Stone in itself is sufficiently strong to withstand the stresses created by wheel loads, it is resistant to wear and impact and it is impervious to water. If we could take crushed stone and knit it together into a pavement that would act as a solid mass of stone, there would be no need for any other material being introduced into the pavement, with the possible exception of contraction and expansion joints. We can approach this condition by grading the stone so as to provide interlocking action of the particles and compacting it to produce maximum internal friction, but we cannot avoid two serious weaknesses. The pavement does not have the necessary resilience to prevent permanent distortion or rutting under wheel loads and the mass is not waterproof and so is subject to the damaging effect of water collecting in the voids. Bitumen is introduced into the pavement to overcome these two weaknesses. The bitumen in itself is a water repelling material; it fills the voids and adheres to the aggre-

[1] Presented at the Twenty-Fifth Annual Convention of the National Crushed Stone Association at Cincinnati, Ohio, February 4, 1942.

gate. Thus the water problem is taken care of and the binding properties of the bitumen enables the crushed stone particles to act as a unit and resist permanent distortion, *that is provided the bitumen adheres to the aggregate particles.* If good adhesion is not obtained, the water can get into the pavement and the unity of the pavement in resisting stresses is lost; in other words, the bitumen fails to accomplish either of the two purposes for which it was introduced. When I say good adhesion, I mean of sufficient intensity to resist the forces that are tending to destroy it. The principal forces that tend to destroy adhesion are those exerted by water. These forces vary with the conditions, for example, a pavement exposed to repeated wetting and drying action or intermittent running water is subject to greater forces acting to break down the adhesion than a pavement that is dry nearly all the time. Likewise, the adhesion of bitumen in surface treatments and cover stones is subject to greater forces acting to destroy the adhesion than the adhesion of bitumen to stone that is interlocked in the pavement and held by high internal friction. This difference in the intensity of the forces acting against adhesion occurring under different conditions is the thing that has led to the common incorrect observation that when a definite stone and a definite bitumen produced a satisfactory pavement in the first location, and an unsatisfactory pavement in the second location that something went wrong with the materials or construction methods in the second location. The likely answer is that the adhesion obtained in both cases was not the same; it was good enough in one case and not good enough in the other. It is evident, therefore, that the function of the bitumen is absolutely dependent upon good adhesion. Among the conditions to be recognized, first, under which good adhesion was not obtained were the *atmospheric conditions, excess moisture* and *low temperatures.* The general method of preventing failures under these conditions is to avoid construction when these conditions exist.

In recent years the nature of the stone itself has been specified as an important condition governing the adhesion of bitumen to aggregates, and aggregates have been classified as hydrophobic or hydrophilic indicating a difference in resistance of the adhesion obtained to the forces exerted by water acting to destroy the adhesion. Tests were devised to distinguish between hydrophobic and hydrophilic aggregates. That immediately brought up the question of what to do about the hydrophilic aggregates. Should we go back to the general method of preventing failures under unfavorable conditions, that is, avoid the use of hydrophilic aggregates? As I emphasized before, the forces that tend to break down adhesion vary considerably from one location to another. We have good service performance records of pavements constructed with stones that are properly classified as hydrophilic, undoubtedly the forces existing in these locations were on the low side. It remains, however, that it is very difficult to present in a convincing manner laboratory test data that indicates the advisability of excluding a product that has a good performance record in one or more locations. You are confronted with the argument that the materials, or construction methods lead to failures in other locations.

The method of attack that promised the best chances for success in taking advantage of this new knowledge was the study of the factors that control adhesion of bitumen to aggregate with a view to obtaining better adhesion with hydrophilic aggregates thus continuing their use by correcting their weakness. Studies were made of the basic physical chemistry involved, and the results of these studies were such as to warrant the expansion of the subject to include the factors that prevented adhesion under adverse atmospheric conditions, with a view to obtaining good adhesion under those conditions. These adverse atmospheric conditions have been sidestepped for so many years that we seldom stop to think that if we could obtain good adhesion under these conditions the crushed stone industry would gain a tremendous advantage. In my opinion there are indications that a satisfactory and economical solution to this latter problem will be found and the application of this solution will greatly diminish the object in distinguishing between a hydrophobic and a hydrophilic aggregate. The actual mechanics of adhesion of bitumen to aggregates is a complicated subject. If we are willing to sacrifice some of the accuracy of the physical chemistry theories, we can obtain a working idea of the subject, and from this working idea we can see the opportunity that does exist for improving the adhesion of bitumen to aggregates.

When considering the adhesion of bitumen to aggregate you must always keep in mind that the bitumen and the aggregate are mixtures of complex chemical compounds. Now the intensity of the adhesion and the speed with which it is effected are different for the different chemical compounds. When an area of stone is covered with bitumen adhesion is not obtained immediately throughout the

entire area, but rather it occurs at various points over that area. As time goes on the number of points of adhesion increase, this is the process we usually refer to as curing. The number of the points of adhesion obtained at any given stage of the curing process depends upon the characteristics of both the aggregate and the bitumen, and the success of the stone-bitumen system depends upon having sufficient points of adhesion, the total adhesive strength of which will resist any stripping forces that may be applied. It follows that the greater the area covered the greater the total adhesive strength obtained and so the greater the success of the stone bitumen system. Complete coverage, therefore, is essential.

In general, if we use the same stone the number of points of adhesion obtained by covering a unit area with a given type of bitumen increases with the viscosity of the bitumen and so decreases with the decrease in viscosity. This is where we run into difficulty when using stone and bitumen in cold weather. The bitumen that would flow over the stone and provide good coverage in warm temperatures thickens up when it hits the cold stone and doesn't flow easily, the result is the area covered is reduced and the number of points of adhesion are reduced. If a bitumen of sufficiently low viscosity to flow over cold stone and provide good coverage is used, again the number of points of adhesion is reduced because the viscosity is reduced. Thus, it isn't possible to get enough points of adhesion to resist the forces that are acting against adhesion and a failure results.

If the same bitumen is used with different stones the number of points of adhesion and the rate at which they increase during the curing varies with the condition of the surface of the stone. The lack of adhesion of bitumen to aggregate that has a surface covered with dust or with moisture is a common observation. It is obvious that in this case the number of points of adhesion are greatly reduced. The chemical compounds that normally adhere first do not seem to be able to get through these surface layers and make adhesion points, and the rate at which the adhesion points increase with curing is so retarded by these layers that the total adhesive strength does not become large enough under regular curing processes to withstand the forces acting against adhesion, and failures result so consistently that we avoid construction under these conditions. In addition the inherent properties of different aggregates affect the adhesion of bitumen. The hydrophilic and hydrophobic classification of aggregates is an expression of this difference.

It follows that any process that would alter the stone or the bitumen in such a way as to produce more points of adhesion and increase the rate of curing would increase the resistance of the stone-bitumen system to attack by stripping forces. A great deal of work has been done along this line, and in general, the results are very promising. Materials have been developed for treating bitumen, and other materials for treating aggregates. These materials are complex chemicals the general nature of which are described in the literature. I am acquainted with commercial processes for treating bitumen and other commercial processes for treating aggregates. I am not acquainted with any process that attempts to treat both the bitumen and the aggregate but I don't question that it might well be done. I have witnessed the construction of stone bitumen pavements under very severe conditions using in some cases treated aggregates and other cases treated bitumens. The results have been so outstanding that I want to describe some of the procedures that are followed, with an emphasis on what mechanical processes are involved.

There are several processes for treating bitumen. All that have come to my attention involve treatment at the bitumen plant by the manufacturer. The properties that control the methods of handling the bitumen, such as the consistency, and flash and fire points are not changed to any appreciable amount. The treated bitumen can be manipulated the same as untreated bitumen. The adhesive qualities are greatly increased and results can be obtained with treated bitumen that cannot be obtained with regular bitumen.

The processes for treating aggregates are much more diversified.

In one method the aggregate is treated in a mixer. The aggregate is placed in the mixer and an emulsified solution is introduced. The aggregate is thoroughly coated with the solution and then about one-half of one per cent of powdered quick lime is introduced. After thorough mixing the stone is ready for use or may be stockpiled for future use.

In a second method the aggregate is heated to a high degree in a dryer and thereafter lightly coated with a heavy water gas tar in a pug mill, causing volatilization of the lighter ends and producing a carbonized product. The aggregate is then stockpiled for use.

In a third method the aggregate is coated with a

treated crude tar primer. One-half of one per cent of treated crude tar primer is sprayed on the stone as it is unloaded from the bins or in a mixer depending upon which method is most convenient. The aggregate is then ready for use or can be stockpiled for future use.

A fourth method involves the use of a water soluble product. A ten per cent solution is made using hot water. The aggregate is coated with one-half of one per cent by weight of solution in a mixer. The aggregate can be stockpiled as the coating that is formed on the surface of stone is insoluble in water.

There are other processes that undoubtedly have merit, but these are the principal ones with which I have come in contact. There is a natural question that comes to mind at this point and I think I had better ask myself the question while I have a prepared statement in front of me, sidestepping it. I might have difficulty in locating the right paper later when someone asks the question, "which of these processes is the best?"

All of these processes have some limitations. My observation is that none of them has as yet nullified the individuality of various stones. They have definitely made the differences in the adhesion of bitumen to various aggregates less marked, but you do still get a little different results with different stones, consequently a rating of the various processes must consider the stone to be used. The best process for you is the process that produces the desired results in the simplest and cheapest manner, and that can be decided only after a study of the various methods and the results they produce with the stone you are marketing.

The use of treated aggregates and the treated bitumen have a very definite place in pavement construction and the importance of that place is continually growing. The logical place to start using these materials is in construction and maintenance work where failures in the adhesion of bitumen to aggregate are most likely to occur; these are: surface treatments, seal coats with cover stone, patching, general construction with hydrophilic aggregates, and *general construction with wet aggregates and cold aggregates.* This latter condition is of unusual importance in connection with national defense projects, and for that reason we are afforded an excellent opportunity to develop these processes.

During the present emergency it is going to be a vital necessity for the associated industries to be prepared to construct and maintain crushed stone pavements under most severe conditions. The knowledge that we have of treated aggregates, treated bitumens and in general about the adhesion of bitumen to aggregates is going to be very useful.

We are confronted by a world situation that warrants our greatest effort, and the more knowledge that we have the better we will be able to direct that effort. I am grateful to your Association for this opportunity to make a small contribution to your knowledge to the end that your industry might better make a great contribution to the defense of our nation.

DISCUSSION

By I. H. BOGGS

General Superintendent, Bituminous Concrete Division, General Crushed Stone Co., Easton, Pa.

THE fact that the lack of adhesion of the bituminous coating to certain types of mineral aggregates in the presence of water is the cause of many failures of bituminous pavements has become apparent very slowly. But this fact has gained universal recognition during the past seven to ten years. I dare say that little or nothing can be found published on the subject prior to 1932. Since that date the subject has become a principal one among those interested in asphalt research.

The problem may be readily divided into two parts:

(1) To develop a method to improve the adhesion of asphalt to the aggregate.

(2) To develop a test that will differentiate between hydrophilic and hydrophobic aggregates and that will also determine the efficiency of the agent used to improve the adhesion of the bituminous coating to the aggregate in the presence of water.

The research staffs of many of the asphalt producers, as well as a few producers of bituminous

concrete have devoted considerable time and money in an effort to develop an agent that will increase adhesion. These agents are commonly called "anti-stripping agents." Quite a number of such agents are now available. They may be divided into two general classes:

(1) Those that are added to and mixed with the asphalt before it is applied to the aggregate;

(2) Those used to coat the aggregate prior to the application of the asphalt.

There is something to be said in favor of and against each class of anti-stripping agent.

Some of the agents that are offered to be added to the asphalt seem not to be equally effective with all types of aggregates. This fact naturally places them at a disadvantage. On the other hand, if an asphalt can be treated with the agent added at the refinery, it permits a more economical operation at the paving plant than one in which the aggregate must be treated prior to adding the asphalt.

Several methods have been developed to treat the aggregate prior to coating with asphalt and a few of them show promise of being very satisfactory in improving adhesion. The precoating agents in general have an advantage in that they work well with any type of aggregate by changing the surface characteristics. Some quarries contain rock of two or more dissimilar types, at least one of which may be very hydrophilic. If the product from such a quarry is pretreated with an anti-stripping agent, then the entire product is made hydrophobic and therefore better suited for use in asphalt pavements.

There is another advantage of the pretreatment method and that is that the sizes of stone commonly used for asphalt pavements may be pretreated and stock piled. From the stock pile the stone may be sold for use in Penetration Macadam, Surface Treatment, Cold Patch or Plant Mix. Since the aggregate has already been processed to improve the adhesion of asphalt, it is unnecessary for the customer to treat it further or purchase asphalt designed to accomplish the same purpose.

Most state highway departments are becoming more and more conscious of the fact that more durable asphalt roads can be built if the adhesion of the bitumen to the aggregate can be improved. Several states on the eastern seaboard are trying one or more of the commercially offered anti-stripping agents in a large scale experimental way. Since no standard quantitative test has yet been developed to determine the relative value of anti-stripping agents, the much slower but perhaps the best test has been resorted to; that is, the test of comparative service record in the pavement.

It is true that Mr. Goldbeck has made any number of accelerated durability tests in the Test Track, using several of the commercially offered anti-stripping agents and some of his test results show vastly increased durability. However, most states are unwilling to accept test results other than those obtained by their own laboratories. Therefore, while I feel confident that there is going to be an increased demand for anti-stripping agents, such a demand is not going to be general throughout the country until a fairly simple quantitative test is developed and accepted by the state highway departments.

Since the only generally acceptable test at the present time for "anti-stripping agents" is comparative service record, I believe that it is well worth while for each producer of bituminous concrete or aggregate used in bituminous construction to investigate the various anti-stripping agents and produce enough of the material for demonstration of its value in service to convince himself as well as local and state highway officials of its merit. Such a program, if diligently performed and promoted, should result in the increased popularity of the various bituminous types which naturally will result in increased stone sales.

Cause of Stripping

Each of you no doubt has heard dozens of theories advanced for the cause of the lack of adhesion of asphalt coatings to mineral aggregates and nothing can be gained by repeating them here. The fact remains that asphalt does tend to leave or strip from almost all mineral aggregates in the presence of water. The degree of the stripping, however, appears to vary with the chemical composition of the rock. In general it may be said that aggregates high in silica are the worst offenders; those high in calcium and magnesium are in the middle ground and the trap rocks have the greatest resistance to stripping. Naturally there are exceptions in all three of these general classes of rock.

A most interesting theory for the cause of asphalt-film stripping has recently been advanced by Mr. R. J. Shaw of the Materials Division of the Arizona Highway Department. I believe Mr. Shaw's theory has not received much publicity and for that reason I am going to take the privilege of briefly outlining it here.

Mr. Shaw's basic theory is that all minerals are surrounded with an adsorbed film of oxygen. He has devised a comparatively simple test which shows that some minerals hold the adsorbed oxygen film tenaciously while others hold the film with but slight attraction. He has gone further and tested at least thirty (30) common rock-forming minerals and determined the tenacity with which each holds its adsorbed oxygen film. Following that he determined the degree of adhesion of a film of asphalt to each of those same minerals and, with but three exceptions, those minerals which firmly hold a film of oxygen fail to hold a film of asphalt. And conversely those which readily give up their adsorbed film of oxygen are the ones to which asphalt will adhere the best.

I can state here that to my knowledge, Mr. Shaw's theory is borne out in practice. I know of two deposits of stone classified as quartzite which give only fair results in bituminous pavements. On the other hand, I am familiar with three deposits known under a comprehensive title as trap rock and which are composed essentially of Biotite, Augite or Hornblend. The aggregates from these three deposits give excellent results in bituminous construction. According to Mr. Shaw's tests those three rock-forming minerals readily release adsorbed oxygen and show little or no stripping in his asphalt adhesion tests, while quartz, which is one of the predominating minerals in quartzite tenaciously holds its adsorbed oxygen film but strips an asphalt film readily.

Since the adsorbed oxygen film appears to prevent the adhesion of asphalt, Mr. Shaw suggests that it be removed by heating the aggregate to at least 700° F. but that is an impracticable and expensive operation, so he further suggests as an alternate that the aggregate be first coated with a light film of oil and then the oil be burned off in the dryer, leaving a thin film of elemental carbon on the stone, which is perfectly compatible with the asphalt.

It occurs to me that while the latter scheme is more practicable than the former, it still is not as simple an operation as precoating the aggregate with an anti-stripping agent after which the asphalt may be added at once or the aggregate may be stock piled and used at a later date without further preparation.

And I might add here that those who have developed anti-stripping agents for precoating aggregates offer a number of theories for the increased adhesion of the subsequently added asphalt, all of which may be wrong. It may be that the new surface presented by the precoating material fails to hold an adsorbed oxygen film and thus permits thorough adhesion of the asphalt.

Regardless of the cause of the lack of adhesion of asphalt to mineral aggregates in the presence of water and regardless of the reason that anti-stripping agents increase the adhesion of asphalt, it is a problem that is coming to the fore rapidly and therefore the producers should give it serious study and be in a position to supply the best treated aggregates and bituminous mixtures as economically as possible.

Discussion

(*Continued from page 21*)

makes a most workable bituminous concrete, adaptable for all sorts of things, and is giving an exceedingly fine account of itself.

MR. BRATT: Mr. Chairman, wouldn't it be an opportune moment at this time to get an expression from Mr. Goldbeck on this matter of stone sand?

MR. GOLDBECK: Gentlemen, I can bear out everything Mr. Rarey has said with regard to the extremely favorable results obtained with limestone sand. When used in sheet asphalt mixtures, we did get extremely high stability with a gradation that didn't resemble the ordinary gradations that go with natural sand sheet asphalt at all, and that stability was obtained with a considerably lower asphalt content; and we had high durability, also.

Let me repeat the natural sand gradation advocated by the Asphalt Institute and, for ready contrast, let me set up a gradation for stone sand which should be suitable for that material.

Fine Aggregate Sand Passing, Sieve No.	Retained on, Sieve No.	Natural Sand	Stone Sand
4	—	98-100	98-100
4	10	8-25	8-30
10	40	15-50	15-60
40	80	22-65	10-60
80	200	7-40	7-40
200	—	0-8	0-8

Defense Against Claims for Damage from Blasting[1]

By HAROLD WILLIAMS
Member of the Boston Bar, Boston, Mass.

• **The problem of a proper defense against claims for damage from blasting is of vital importance to crushed stone producers. Mr. Williams' experience in this field is most extensive and his observations should be of real practical value.**

FOR the past three days we have been privileged to focus our thoughts on very high things. We have listened to discussions of those questions of great national interest and world importance that are seething through our minds at this time. At this late hour, it seems more than usually unfortunate, perhaps, that we should have to stop thinking of higher things and come down for a few moments to a very unpleasant topic that is one of the disagreeable incidents of our everyday life as stone producers.

As the demand for our product increases, and as populations increase around us, it is natural to expect and to find an increase in those complaints of neighbors of our operation that they are affected injuriously by blasting operations. Those complaints are of two sorts: One is the actual throwing of rocks off your property onto the property of someone else; and the other is the indirect injury which you may do—not which you do do but which you may do theoretically—through vibrations arising from quarry blasting.

Of the first, it is unnecessary to speak except to say that there is, of course, no justification for throwing rocks on anybody. It is not a normal incident of proper quarry operation. When it happens, it is an accident, but it is an accident for which you are responsible and the only thing to do is to recognize that responsibility, being careful, however, not to couple it with any admission of causing damage by vibration.

The important question for us to talk about in this connection is, of course, vibration, which is not a direct injury. It is not a trespass; it is merely a claim of an improper use of your own land. Perhaps it seems unnecessary to dwell upon that distinction, but it must be observed because the complaints that are made will group together the throwing of stone (if they can find any) and the vibrations, and it is most important that those two things be not confused.

A vibration is not a blow; it is not an impact or a concussion; it is the result of a blow delivered somewhere else, at a distance, and delivered at a place where you have a right to deliver it, that is, on your own land. That means that these cases are not explosion cases. It is not as though something blew up on the ground and spread out and struck something, or caused air waves which struck something. It is not important at all to the effect that a vibration may have, to know that it originated from a dynamite blast; it is just as harmful, if it is harmful at all, no matter what its origin is; so that these cases must not be discussed, and you must not allow them to be treated, as explosion cases. They are vibration cases, and that is all.

The law governing liability for causing damage to adjoining or nearby property from vibration, is not uniform. In some states it is held that anyone who uses an explosive for any purposes, uses it at his peril, and consequently, he is liable if it causes damage, even when he was not negligent in using it. But in other states—and I think in most of the states—it has been established as law that for this indirect sort of damage which results from vibration, you are not liable unless you were negligent. Negligence in that case means negligence not only in the proper and orderly operation of your blasting, but it might also extend to blasting of such unreasonable size, all things considered, that it ought not to be done with due regard to the safety of neighboring property. Negligence does not, however, mean that any damage that you cause is an indication that you were negligent. It does not go as far as that.

There are several forms in which the attack upon you may be made; there are several forms which the complaint may take. It may be that you are sued in the law courts for the damage which you have done and you face the possibility of a money judgment; or again, it may be that in addition to that, an injunction is asked for, which may restrict or conceivably prohibit your operation altogether. Your question,

[1] Presented at the Twenty-Fifth Annual Convention of the National Crushed Stone Association, Netherland Plaza Hotel, Cincinnati, Ohio, February 4, 1942.

I suppose (and my excuse for being here), is: How are we going to protect ourselves from claims of either character?

Now, it is true that you may interpose, or your attorneys may interpose legal objections, technical defenses. I don't propose to talk to you about anything like that at all, because you are not a group of lawyers but a group of businessmen. There is, however, one conclusive answer which does not depend upon the niceties of the law but is grounded in actual fact, and that is that your vibrations haven't caused and are not causing any damage.

Up to about twenty years ago, or perhaps a little longer than that, there was comparatively little quantitative knowledge or information as to what the damaging effect of vibration was, but since that time, extensive field work has been done, considerable studies have been made, and valuable information has been collected and collated and made available for us. The result of this study over this period has been surprising, as well as gratifying. Until quantitative measurement was attempted, the judgment of the effect of vibration was largely the human judgment. The human body is intensely receptive of anything that disturbs its sense of balance. Even learned men have been known to feel vibrations and describe them as being immensely greater than, in fact, they turned out to be when measured. Consequently, these measurements have reassured us greatly as to what we are doing, and I think the general statement can safely be made that such vibrations as result from normal quarry blasting under the usual conditions are too small to damage structures in the immediate vicinity.

There are also the complaints not limited to physical things—complaints of injury to health or nerves of individuals involved. Those things, of course, defy any human scale of measurement, but the fact that vibrations, when measured, are somewhat smaller than anyone, by feeling them, would suppose them to be, is a useful answer to complaints of that character.

The difficulty, of course, in the defense of complaints of damage by vibration is that those who make them—and they almost always make them with some basis of good faith—are ready to come into court and tell you what they have seen happen. They will call attention to cracks in the wall which were not there, or were not observed to be there, before the blast and now have appeared. This eye-witness evidence is difficult to combat; it is difficult to contradict. We can't supply eye-witnesses to the contrary, to say, "I was there at the time and noticed that no crack appeared." What we have to rely on, and usually all we have to rely on, is to show that those people, mistakenly or not, are not telling you the facts, and what they say happened did not happen, because it couldn't happen. It was a physical impossibility that vibrations of the size resulting from a particular blast could have caused the damage attributed to them.

That, of course, is a difficult line of defense. It is pretty hard to have somebody say that what you say is not true because it is impossible. You have got to point out that impossibility very clearly. It cannot be left as a matter of opinion, even expert opinion, because you will get so-called expert opinion that will contradict that. It must, then, be established as a matter of fact, and that is the real problem in dealing with these claims. The defense is not a legal one at all. It isn't a legal problem at all. It is a factual problem, one that must be brought out by expert witnesses and then translated to the tribunal which must pass on it in such a fashion that it may be evident as a matter of fact.

Vibration is a shaking motion which travels in a wave. The shaking may be up and down, or it may be to and fro in the direction of the wave, or it may be across and back transversely in the direction of the wave, or it may be—and most commonly is—a most confusing conglomeration of all those three directions. As the wave travels, carrying this vibration with it, the vibration enters into every particle of the earth through which the wave travels. That part of the earth shakes to and fro. When that shaking stops and that portion of the earth comes to rest, then if no harm has been done, the effect of that vibration is over and there can be nothing added to it, and there is nothing which it can contribute to the effect of following vibrations.

The weakest parts of a building are those which are visible, and if no injury has been discerned when the particular vibration has passed away and the earth has become quiet again, there is nothing left. This is interesting and it is useful, because we so often hear the argument made: "Well, perhaps that one didn't do any harm, but you can't tell me that you can go on blasting week after week, and month after month, and not injure my building." Well, you can. There is nothing more cumulative about it than adding a row of zeros.

A vibration has two elements, as you probably know. Those are described in terms of space and in

terms of time: the element of displacement, which we call *amplitude*, and the rate at which that displacement occurs during the activity of the vibration at that particular spot, which is called the *frequency*, which, by the way, has nothing whatever to do with the length of time that the vibration lasts. Both amplitude and frequency, and of course, also, the duration of the vibratory effect at the particular place, can be measured by a siesmograph or a siesmometer—they call them various names, but the principle, to a lay mind, is much the same, and the results are much the same. By obtaining the amplitude and the frequency, you have the data from which the effect of the vibration can be ascertained.

I may say that when I first talked to this Association fifteen years ago, in Detroit, on this subject, I did so with a degree of confidence I do not feel in discussing it today. It seemed then a fairly simple matter. Today the investigations of the scientists have rendered it so extremely difficult that I touch very diffidently on that phase of what I have to say.

Scientists don't agree on exactly how you are going to determine the destructive force of a vibration. One school of thought appears to be to apply a formula in which both amplitude and frequency are used, and find the acceleration or increase in rate of speed, and then reduce that to terms of static pressure, and compare that static pressure with the resistance strength of the house or the various component materials of the house.

Another school of thought, another method, concerns itself more directly with the amplitude alone, which is considered by far the most important element in a vibration. The result of a great number of actual tests in the field over a period of something like twelve years has satisfied one leading expert on this subject that no amplitude or displacement less than 4/10ths of an inch has ever been found which caused damage to ordinary buildings, no matter how frequently it might have occurred during the time the vibration lasted.

The value of the sets of pins, with which you are all familiar, has been questioned by some scientists, but there, again, you have a difference of reputable scientific opinion.

For me to enter into any discussion of questions such as this would be presumptious on my part, and would be useless to you.

As practical people, it is enough for us to know that all these investigations, however worked out, lead to the same general result as far as we are concerned. They all agree that such vibrations as are caused by normal quarry blasting are many times too small to be dangerous. The Bureau of Mines now has in course of publication, the last bulletin covering a series of investigations that it has made for some years. I wish you might have had the benefit of it now, but this I am authorized to say, that this is one of the conclusions which they have arrived at after years of study and experiment, and it will appear in their bulletin when it comes out in some such form as this: "The effect of blasting in quarries under normal conditions as related to distances between shot and house, is no more damaging than vibrations caused by ordinary street traffic or customary movement of occupants of the building." That is one of the conclusions we have had from the Bureau of Mines.

You will understand, of course, that all these measurements are not the exact results which would be obtained in a science like mathematics. You are dealing with physics. You are not dealing with abstractions. You are dealing with measured facts, and what you get is always an approximation rather than an accurate measurement. That is more particularly true from the fact that you very rarely have a seismograph set up at the exact point that you would like to have it set up. The result which you reach must be an approximation, at best. But for our purposes, such an approximation is enough because the figures show that these vibrations are so infinitely small in comparison with what they would have to be to cause the damaging effect attributed to them, that there is no possibility of harm from them.

For instance, you don't know whether an ant can carry twice its weight or ten times its weight—perhaps nobody knows— but you do know that it can't move a cobblestone. So in this field here, we don't know, and we don't care, whether an amplitude is five-thousandths of an inch or one hundredths of an inch, when we know it would have to be forty or eighty times as big as that in order to reach threatening proportions.

In one case of which I know, it was established and found as a fact by the Court that the vibrations would have had to have been 400 times as big as they were in order to reach the point where they could be damaging; and that meant that the use of dynamite would have to be, not 400 times as great, but three or four times 400, because vibration does not necessarily increase from the increased charge of explosives.

What are the precautions which quarry owners

should take where complaints of this character are apprehended? In the first place, of course, if permits or licenses are necessary, they should be scrupulously obtained and maintained. Compliance with a license is very often a *prima facie* defense. Unlicensed operation may be, in and of itself, a cause of liability.

Next, an accurate record of shots should be kept, showing the date, the hour, the number of holes, the spacing between holes, the depth of the holes, the setback from the face of the ledge, the details of the loading and the amount of explosive used, which should, of course, show that you are not using an unreasonably large amount of explosive.

It is also well, where you anticipate complaints, to have a seismographic measurement taken at the time of a normal blast, or perhaps one that is a little larger than the normal, setting up your seismograph as near the source of complaint as you can reasonably get it. It is also helpful to use the pins on all shots, if that is feasible.

Now when you are actually in court, you must be in a position to show, first, that your methods of operation are free from negligence, and efficiently and properly conducted, and that as to their extent, they are carried on with a reasonable regard for the rights of the adjoining property owners. You must then be in a position to show that, by reason of the measurements which you have taken, it is a matter of scientifically established fact that the vibrations which you cause don't come anywhere near within the range of danger to structures.

There is a further element of defense which has been found to be of very great value. You don't get complaints unless something is the matter with the man's building. There are cracks there; there are defects there upon which he bases his complaint; otherwise, you wouldn't have the complaint. It isn't enough to show that you were careful and that your vibrations were too small to have caused any damage. You should be in a position to show what did cause the defects or cracks of which he complains. A competent, practical engineer or builder can always explain the conditions and what gave rise to them. Have him go there and measure the house, go all over it—the foundations and everything else—and the builder can tell you, and afterwards he can tell the court, what did cause the cracking and the defects complained of. Settlement causes cracks; expansion and contraction of materials through changes of temperature and weather conditions, particularly where timber is placed horizontally, cause cracks. The nature and direction of the cracks betray their cause, and cracks caused by settlement or by shrinkage of materials are entirely different from the sort of cracks that vibration would cause.

I have been informed (and I give it to you for what it may be worth) that one department of the Government has listed approximately forty sorts of reasons for cracking in plaster in buildings; so that there is plenty of explanation available for what caused the plaintiff's damage in all these cases.

When you are satified that you can meet the issue, when you are satisfied that your operation is proper and reasonable, that the vibrations are so small they couldn't have done the harm alleged, and when you have gone further and shown what did do that harm, you have done all, then, that you can do to defend yourself against honest claims, claims brought in good faith. Of course, the claim brought by the hold-up artist presents a problem, not to you, perhaps, as much as to your lawyer; but I am speaking in the main of honest claims, because they mostly are that.

As I say, you have done all you can, then, to meet them. Undoubtedly, it would be a whole lot cheaper to settle any one case than to fight it, because these are not cheap cases to fight. They take a long time and they require expert assistance, and undoubtedly you would save money by settling. I don't believe that anybody needs much persuasion today of the worthlessness of a policy of appeasement. If you have got many neighbors around, the settlement of a case with one of them is an extremely dangerous thing. In the long run, the initial cost of defending one case carefully and successfully is the surest guarantee against a tidal wave of claims and suits; so that when you know you are right, the safest course is to stand by your guns and fight it out.

Bureau of Mines Issues Bulletin on Damaging Effects of Quarry Blasting

THE U. S. Bureau of Mines has recently issued Bulletin 442, entitled, "Seismic Effects of Quarry Blasting," prepared by J. R. Thoenen and S. L. Windes. A brief review of this publication indicates that it should be of the utmost value to quarry operators who may be confronted with the necessity of defending suits from alleged damage from blasting.

Copies of the Bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents per copy.

Recent and Proposed Federal Legislation Relating to Industry[1]

By JOHN C. GALL

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Washington, D. C.
Formerly Counsel, National Association of Manufacturers

• As Mr. Gall has so ably demonstrated on many occasions, he is exceptionally well informed concerning Federal legislation and its relation to industry. Today a knowledge of such matters is increasingly important. His observations in the following discussion should prove of real value to the crushed stone producer.

IT IS a great pleasure to be with you here again. I appreciate particularly the privilege of coming, now that I am no longer connected with an organization. One is apt to feel, when he has been connected with an association of some kind, that his invitation is largely on account of his position in the association. I do not have that feeling this morning. I am here as an individual, and I am pleased particularly to come back, as I have been able to come back among you during past years, as a friend, and a friendly adviser.

As Mr. Rarey says, when we looked at the title that had been assigned to me, it seemed that the field was too narrow because there had been so few developments that were peculiar to the crushed stone industry in the administration of the Wage-Hour and Walsh-Healey Acts. On the other hand, I think we all feel that anything that is of interest to industry generally must be of interest to the members of this industry, because you can't have general legislation that doesn't touch and affect and concern the people of every industry.

Much of the legislation that has been enacted since you met a year ago has related to the national defense effort, now more appropriately called the war effort. As we look back on this picture for the last year or so, we find that the war program has been divided into three very definite segments or periods of time. First, in 1940, you will recall, we had a presidential campaign going on and nobody was talking in terms of this country's engaging in the war. We were all talking in terms that our boys were never going to be sent abroad, that this country could stay out of the war. In fact, that was the thesis on which both of the presidential candidates were campaigning during the year 1940; so that we were very definitely, during the year 1940, in a period of pre-defense. We were not even talking in terms of an all-out national defense program.

Early in 1941, after the presidential election, the program changed considerably. We passed the Lend-Lease Law, and then we began to talk in terms of all-out defense, but it was still accepted as a national policy in the early part of 1941 that this country was not going into the war as an active belligerent, and that we could best defend America by helping Great Britain and her allies; and that was the program in 1941, up and until the latter part of the year.

Then in December of 1941 came Pearl Harbor, and since that time we are no longer talking about a defense program; we are talking about an all-out war program.

I only analyze those three time factors for the purpose of showing that the legislation which is of interest to this industry, which has been enacted during that period, has all been keyed to the state of mind of the public with respect to that major question of what was our relation to the war.

Cost of the War

This war program is costing a lot of money. If we look back, we see that the amount of money that has been asked for by the Administration, and has been approved by Congress from time to time, has been directly in proportion to what the state of mind was with respect to our participation in the war. In 1940, for instance, during the presidential campaign, the President had asked for only a little over one billion dollars for national defense. That began to be stepped up, and by the end of 1940, after the elections in the fall, we had committed the country to an ex-

[1] Presented at the Twenty-Fifth Annual Convention of the National Crushed Stone Association at Cincinnati, Ohio, February 3, 1942.

penditure of about seventeen billions of dollars in connection with national defense.

The budget submitted in January of 1941 called for national defense expenditures of about ten billions of dollars, and by the time of Pearl Harbor, in December, our total national defense appropriations and authorizations had reached sixty-eight billions of dollars, a figure that never was anticipated or talked about a year earlier.

We are now thinking—I say "we"; the country as a whole—in terms of this war effort's costing somewhere from one hundred fifty to two hundred billions of dollars. When we consider that the total estimated national wealth of the United States is about three hundred billions of dollars, and we consider that we may spend from one hundred fifty to two hundred billions of dollars in connection with the war effort, we can see how much of a mortgage we are talking about putting on all of the resources of this country, and that is something that I think affects every businessman, both in his capacity as a businessman and in his relationship as a citizen to his government.

Tax Policy

The question of how to pay for this, the question of taxes, has been, of course, and is extremely important. At the outset of the defense program, the Administration's objective, so stated by Mr. Morgenthau, was to raise approximately two-thirds of all the cost of our defense program by current taxation, and one-third of it by borrowing. That objective is rapidly being forgotten. We have now shifted over more nearly to a basis of one-third of the total raised by current taxation and two-thirds by borrowing. Mr. Morgenthau made a speech in Cleveland a week ago last Saturday in which he stated that we could expect to spend during 1942 fiscal year approximately forty billions of dollars, and that it would be necessary to raise this year approximately nine billions of additional revenue. You can see, therefore, that the ratio of current taxation to total expenditures is rapidly dropping, and that instead of two-thirds and one-third, we are approaching the one-third and two-thirds basis.

In September of 1941, Congress passed and the President signed the Defense Revenue Act of 1941. That was proposed to add about three and a half or four billions of dollars to the income of the Government, based on previous tax laws. You will recall, of course, that that measure increased the personal and corporate levies, decreased the exemptions, and added a series of new consumption taxes—taxes on various things such as passenger transportation, telephone and telegraph messages; a lot of luxuries, such as jewelry, furs, and so on; new taxes on business machines, on light bulbs, electric signs; electric, gas and oil appliances; and increased similar taxes which already applied in the case of automobiles, tires and tubes, radios, refrigerators, toilet preparations, and so on.

We are now up against the proposition, as Mr. Morgenthau states it, of passing a new revenue act which will increase the total revenues of the Government by something like nine billions of dollars. Now, the revenues derived from general business taxes have pretty nearly reached what most people consider to be the saturation point, and about the only alternatives left to the Government are the general sales tax, (which is very distasteful to the politician), and some form of withholding tax, so-called, which means nothing more than an addition to the payroll taxes—because the only place there is left from which to withhold it is from the employees of the country through additional payroll taxes. So, as I say, Congress is right up against the proposition either of not financing any more of the war program by current taxation (which is not in the cards yet), or of going to a general sales tax, or of taking more out of the pay envelopes of the nation's workers in order to pay for the program as we go along.

Social Security Taxes

There are proposed also, and pending, some tremendous increases in Social Security taxes, aside from the proposal I have just been speaking of for raising more money for general governmental purposes. The President has recommended a two billion dollar increase in the collections from Social Security taxes during the next fiscal year. You probably recall that at some earlier meetings of the National Crushed Stone Association, when we discussed Social Security problems, I undertook to point out this, that based on the experience in England and other countries, we would soon find that the Social Security scheme was subject to exactly the same kind of pressures as are the workmen's compensation laws. You know that at every session of the state legislatures there are movements on foot to decrease the waiting periods, to increase the benefits, to cover occupational diseases which have not been covered before, and so on. Now in the case of Social Security, the same movement is taking place. We are finding a

movement to decrease the waiting period, to increase the old-age benefits, to increase the unemployment compensation benefits, to increase the period of duration of the payment of these benefits, and all with a very considerable cost by way of payroll taxes.

The President, in his January budget message, asked for an additional two billions of dollars in connection with Social Security for the purpose of increasing the coverage of the old-age pension scheme, for providing permanent and temporary disability benefits, for hospitalization payments, and for liberalization of the unemployment compensation benefits. You will recall that we have previously discussed the fact that a complete scheme of Social Security would be designed to meet five hazards which are known to everybody: one is unemployment; one is sickness; a third is accident; the fourth is old age; and the fifth is death; and it is perfectly obvious, when you read the President's budget message of January, that he has no idea of stopping the spread of the Social Security program until those five hazards—certainties in the case of old age and death—are in some way insured by the Federal Government, because he is no longer willing to leave it as a state matter in the case of unemployment compensation. He has clearly indicated the intention to federalize the whole program of Social Security. So we may look for a broadening of this, notwithstanding the fact that it might be well, many people think, to delay an extension of this matter until after we have gotten out of this war period and have found the revenues for paying for the war, rather than extending further at this time the Social Security benefits.

Supplementary Unemployment Compensation

The President has also asked for an appropriation of three hundred millions of dollars for the purpose of paying supplementary benefits to those people who may be temporarily out of employment due to the conversion of peace-time industries to war-time needs. That program was particularly directed at the automobile industry, but it is designed to be applicable generally throughout industry. The exact method of payment of those benefits has not been outlined yet, although a bill has been introduced, at the President's request, by Congressman Cannon, of Missouri, which outlines one method that might be adopted. The method that has been suggested so far of paying those benefits has been by supplement to state unemployment compensation benefits, by reducing the waiting periods under state laws, by increasing the benefits under state laws by this Federal supplement, and by extending the duration of those benefits.

Highways, Housing and Community Facilities

A matter, of course, in which you people are greatly interested is the matter of appropriations and plans of the Federal Government with respect to defense highways, housing and community facilities. In August of 1941, the President vetoed an appropriation bill carrying three hundred twenty millions of dollars for defense highways. Later on, as you know, in November, he signed another measure, a substitute measure, carrying an appropriation of one hundred seventy million dollars for defense highways.

A community facilities bill was passed in June of 1941, carrying one hundred fifty millions of dollars to the Federal Works Agency for the purpose of providing public works in defense areas, those public works to consist of schools, hospitals, recreation and sanitary facilities, streets and access roads. There is now pending a second bill carrying an additional appropriation of one hundred fifty million dollars for the same purposes. That bill has passed the House and is now pending in the Senate. Three hundred million dollars have been appropriated for defense housing. The President has requested another three hundred million dollars for this purpose, and this is now pending in the Senate, having passed the House of Representatives on the day we declared war on Germany and Italy.

Price Control

Then there is the subject of price control. I don't know how intimately this industry is affected yet by Mr. Henderson's activities, but I am sure if you aren't already, you soon will be. In July, the President asked for the passage of a general price control measure. It was designed, of course, as a brake on inflation. However, a price control measure, as we have seen already by the methods suggested to Mr. Henderson for the exercise of his powers, can also be a very effective measure for preventing the making of excessive profits. In other words, it may serve a double purpose, both of regulating profits and of regulating prices so as to prevent runaway inflation. It is a very natural question to ask where Mr. Henderson has been getting all his power

since last July, when the measure which authorized him to engage in these activities has only been signed by the President within the past few days. That, however, is a somewhat academic question now, I assume, because up to the time that the measure was signed, nobody had undertaken to challenge Mr. Henderson's power in a court proceeding.

There were a number of principal points of dispute in connection with the Price Control Bill when it was pending in Congress. One was whether it would be administered by a single administrator—that is, Mr. Henderson—or by a board or committee. That has finally been resolved in favor of the single administrator plan, and with Mr. Henderson being the administrator. The second question on which there was considerable dispute was whether the measure should be limited to authorize the placing of price ceilings on industrial goods, or should also cover rents, wages, and agricultural products. The House defeated the proposal for overall price fixing, but did include agricultural products on a formula which would put a floor under the prices that could be fixed by the Administrator. The way the bill has been enacted into law, it still does not cover wages. It does cover rents in defense areas. It does cover agricultural products with a formula under which the Administrator is given a floor or a number of floors below which he may not go in the fixing of ceilings on agricultural products.

One of the most controversial sections of the bill dealt with licensing. The Administrator contended that he needed the licensing power as a weapon to bring people into line where they did not conform to the price ceilings fixed. Others argued that it was unnecessary to have a licensing system, that that was in the direction of regimentation, and that they should depend on the penalties in the bill and not on a licensing system. As the bill was enacted into law, it does carry a licensing provision, but it is a very different licensing provision than the one originally proposed by the Administrator, because this provision provides for automatic licenses, which may be either to individual companies, individual producers, or to industries as a whole in the form of blanket licenses. It is also provided that the Administrator shall not have the arbitrary authority to revoke a license merely because he finds that somebody has not lived by the rules laid down for him. It takes a court proceeding under this provision to revoke anybody's license, so that is a very considerable protection not accorded in the bill as it was first introduced.

There is also a very interesting and somewhat novel provision in this price control bill known as the buying and selling provision. I am not sure whether that may be of any interest to members of this industry. It probably will be necessary to see how it is applied before you can tell. That provision is to the effect that wherever the Administrator finds that it is necessary, in order to assure maximum production of some commodity which is not being produced in sufficient quantity, he may go into the market and may buy, sell, store, or otherwise handle or dispose of any commodity. Now, you can see that in the case of certain commodities where the production is low—and that would be particularly true in the case of some minerals—a provision of this kind might enable the Administrator to fix one general price ceiling for the industry, but himself to depart from that price ceiling by making contracts with individual high-cost producers for bringing additional production in that would not be produced under the general price ceiling. The whole purpose of that is to bring in additional production, particularly in the case of minerals, and it may have some application in your industry, at least in some areas, after it has gone into operation.

Two other provisions of the Price Control Bill are, I think, of particular interest. One is that the bill provides for an emergency Court of Appeals. This was in the nature of a compromise with those who believed that the bill ought to be administered by a board or a committee instead of a single administrator. They have left it so it is to be administered initially by a single administrator, but there is provided an emergency Court of Appeals which can hear appeals from the decisions of the Administrator. There is also a provision for industry committees, so that where the Administrator is going to fix a general price ceiling for a commodity—that is, for a whole industry—he may cooperate with the industry by having an industry committee set up.

Industry and the Anti-trust Laws

One of the matters of great concern to some industries has been whether the members of the industry could form a committee and sit down as a group and discuss matters of price without running the risk of violating the anti-trust laws. This provision is written into the Price Control Bill for the avowed purpose of giving legal sanction to industry committees which will sit down with the Price Administrator and try to work out these matters of price ceilings with respect to their industries without

the risk of anti-trust prosecutions. The provision is somewhat vague and it is still problematical as to how far it gives exemption from the anti-trust laws. Nevertheless, it is a step in that direction and probably will be welcomed by all those industries that have to sit down with the Administrator to try to work out a price structure.

Motor Transportation

Another matter that I know is of particular interest to this industry is the matter of motor transportation, particularly trucks. As you know, ever since the passage of the Wage and Hour Law, there has been a dispute as to the jurisdiction of the Wage and Hour Administration and the jurisdiction of the Interstate Commerce Commission over truck drivers and other employees engaged in truck transportation but not necessarily drivers of the trucks—that is, helpers and handlers, and so on. That dispute has not yet been resolved by any court decision or any authoritative decision of the Wage and Hour Administration or the I.C.C. The only thing that has been decided is that the jurisdiction of the Interstate Commerce Commission is confined to those employees whose employment has something to do with safety of operation, and therefore, the Interstate Commerce Commission does not have jurisdiction over those other employees that I have been mentioning, such as helpers and handlers of goods, who may be on the truck but who are not actually concerned with the safety of operation of the truck. Those are still left in this area of doubt as between the I.C.C. and the Wage and Hour Administration.

I think if you have not read an address made by Mr. Joseph B. Eastman, Director of the Office of Defense Transportation, delivered in Washington on January 27, that it would be extremely useful for every member of this group to do so. I have read this address with a great deal of interest, and all of you who are interested in private motor carriers, in the operation of trucks in your own business, will want to see what Mr. Eastman's attitude is toward that problem during the war period. It is quite revealing. I will not undertake to read it to you, but Mr. Eastman makes several points: one, that there is no intention on his part, as Coordinator of Transportation, of federalizing or taking over or regulating, beyond what they are now regulated, private motor carriers; furthermore, that he thinks that the industry ought to remain strictly private, not publicly operated; that he feels, also, that provision for adequate truck transportation for the handling of materials, both in and about plants, and from plants to other plants, to delivery points, is just as essential as the production of munitions themselves in connection with the war effort; and that he is going to use his office in such a way, in so far as it is possible, to insure to the people who are dependent on truck transportation that they get the necessary equipment facilities for carrying on their business. I think it is a most constructive approach to that whole problem and will go a long way toward allaying some of the fears that people have had who are so dependent upon truck transportation.

Mr. Eastman concluded with a note which I wish we could get from all the administrators of these various war measures. He said, "Some of you, I am told, are apprehensive that an attempt may be made to bring private carriers in some way within the fold of public regulation, like the for-hire carriers under the Motor Carrier Act. My responsibility is to see to it that transportation functions efficiently and effectively in the war effort. I see no present reason why I should concern myself with this problem of regulation, and if I should later, by any chance, be of a different mind, you may be sure that I shall let you know and solicit your views before arriving at any conclusions." That is a very constructive approach to the whole problem of motor truck transportation.

Labor Legislation

One other subject of legislation I think is of particular interest to all industry, and that is the matter of labor legislation. I think that it is safe to predict that there will be no overall relaxation of Federal labor legislation. I mean by that that many of the measures which have been put on the books during the past eight or ten years are going to stay there, war or no war. The only measures which may be relaxed in this field, either by Executive Order or by Congressional action, in my judgment, are those which in some way put a restriction on production, either by setting a maximum number of hours that may be worked, or by imposing an overtime penalty on hours beyond a certain fixed number. In other words, maximum hours may be relaxed; the overtime penalty may be relaxed; but there is not going to be any relaxation, in my judgment, of the general statutes, such as the National Labor Relations Act dealing with collective bargaining, or those provisions of the Wage and Hour Act which have to do pri-

marily with minimum wages rather than maximum hours. I believe in considering what relaxations of labor laws may take place during the war, it would be well to think only in terms of taking off restrictions on maximum hours rather than on relaxation of any of the other provisions of law.

You will recall that in 1940, the House of Representatives passed the Smith amendments to the Wagner Act. Those amendments died in the Senate. There was no further action of a legislative character until December, 1941, and on the 3rd day of December, last, the House of Representatives again, by a vote of about two to one, passed a bill which was designed to put some restrictions on labor organizations. This bill likewise was sponsored by Representative Smith of Virginia. After this bill passed the House and went over to the Senate Committee, the labor organizations got together, as they usually do when they are in danger of having legislation passed, and for the moment buried their hatchets (not in the usual place); a conference was called by the President to meet in the City of Washington on the 17th day of December for the purpose of devising some machinery for the handling of disputes during the war. That conference was composed of twelve employer members and twelve labor members.

National War Labor Board

I served as counsel to the twelve employer members to that conference during the period that they met in December, in framing the proposals which led to the creation of the National War Labor Board. I was not in any sense a government appointee; I was simply a private counsel to the twelve employer members of that conference, and it was an extremely interesting experience to sit with them and to hear the proposals which were put forward in these joint conferences, to discuss the possible practical application of them, and to see the final result in the form of the National War Labor Board which has now been created.

That Board has just begun to function, the members having been appointed on the 12th day of January, and the first meetings having been held only a couple of weeks ago.

Since the creation of the National War Labor Board, we have had two or three governmental reports that are extremely interesting, bearing on the question of the need for legislation further regulating labor organizations. The Truman Committee of the Senate, about which you have read a lot in the papers, held that there should be Congressional consideration now of labor legislation. The Naval Affairs Committee in the House also recommended that there should be legislation; and finally, what is perhaps more surprising than any of those, the Secretary of Labor, in her annual report which has just been submitted, recognizes the existence of a great many practices that are harmful to labor in the union movement, and although she does not squarely recommend legislation, she has identified so many of the practices with which industry is familiar that there is very little question that that will give some impetus to Federal legislation.

In my own judgment, the War Labor Board is not the final answer to our labor problems. It may be able to do a constructive job in handling some of the worst disputes that arise during the war, but the area covered by the War Labor Board is so narrow, and the lack of penalties is so obvious, that it seems to me that it would be well to have Federal labor legislation along the lines of the Smith Bill which has passed the House of Representatives, and I hope that we are going to see continued pressure for some legislation of that kind until we get it. The present situation, I think, is intolerable. We have passed a number of statutes, all of which apply to employers, but with no counterbalancing provisions with respect to labor organizations. We have also seen court decisions by the Supreme Court, including particularly the Apex and the Hutcheson cases, in which labor organizations have been held to be exempt from the anti-trust laws. We have also seen a number of court decisions in the field of administrative law which hold that the courts, for all practical purposes, will not review the findings and decisions of these administrative agencies, such as the National Labor Relations Board. The result is that today we have a labor union movement (regardless of what one's attitude may be on the subject of collective bargaining) which is practically exempt from all of the laws which apply to other members of our society, and particularly to employers as such. I believe that we will not see a solution of our difficulties in the field of labor disputes until we have some equalizing legislation on the statute books.

Mr. Chairman and gentlemen, I have taken up more time than I really intended to, and I realize this has been in the nature of running comment rather than a speech. I hope it may have brought to you a few things that will provoke thought and discussion during your sessions. Thank you very much for having permitted me to be here.

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